COMPARATIVE EVALUATION OF REMAINING DENTINAL THICKNESS AFTER PROTAPER NEXT, NEOENDO FLEX, MTWO ROTARY FILES PREPARATION USING CBCT -

AN IN VITRO STUDY

A Dissertation submitted
in partial fulfillment of the requirements
for the degree of

MASTER OF DENTAL SURGERY
BRANCH – IV
CONSERVATIVE DENTISTRY AND ENDODONTICS

THE TAMILNADU DR. MGR MEDICAL UNIVERSITY
CHENNAI – 600 032
2015 – 2018

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **“COMPARATIVE EVALUATION OF REMAINING DENTINAL THICKNESS AFTER PROTAPER NEXT, NEOENDO FLEX, MTWO ROTARY FILES PREPARATION USING CBCT- AN IN VITRO STUDY.”** is a bonafide and genuine research work carried out by me under the guidance of **Dr . M. KAVITHA , MDS, Professor & HOD,** Department Of Conservative Dentistry and Endodontics, Tamil Nadu Government Dental College and Hospital, Chennai-600003.

DR .M. ASSMEE

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This is to certify that **Dr.M.ASSMEE,** Post Graduate student (2015-2018) in the Department of Conservative Dentistry and Endodontics, TamilNadu Government Dental College and Hospital, Chennai- 600003 has done this dissertation titled **"COMPARATIVE EVALUATION OF REMAINING DENTINAL THICKNESS AFTER PROTAPER NEXT, NEOENDO FLEX, MTWO ROTARY FILES PREPARATION USING CBCT- AN IN VITRO STUDY."**under my direct guidance and supervision in partial fulfillment of the regulations laid down by the Tamil Nadu Dr.M.G.R Medical University Chennai - 600032, for M.D.S., Conservative Dentistry and Endodontics (Branch IV) Degree Examination .

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Above all I pray and thank THE ALMIGHTY GOD for his continuous grace and blessings in my every endeavour.

In His time He makes all things beautiful!

DECLARATION

TITLE OF DISSERTATION	**"COMPARATIVE EVALUATION OF REMAINING DENTINAL THICKNESS AFTER PROTAPER NEXT, NEOENDO FLEX, MTWO ROTARY FILES PREPARATION USING CBCT- AN IN VITRO STUDY."**
PLACE OF THE STUDY	Tamil Nadu Government Dental College & Hospital, Chennai- 3.
DURATION OF THE COURSE	3 YEARS
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And

Mrs. Dr. M. Kavitha, MDS aged 48 years working as **Professor** in Department of Conservative Dentistry & Endodontics at the college, having residence address at 191/5, Green Fields Apts. R-30A, Ambattur, Thirumangalam High Road, Mugappair,Chennai-3 (herein after referred to as the Principal Investigator)

And

Mrs. Dr. Assmee.M aged 32 years currently studying as **Post Graduate student** in Department of Conservative Dentistry & Endodontics, Tamil Nadu Government Dental College and Hospital, Chennai 3 (herein after referred to as the PG student and coinvestigator).

Whereas the PG student as part of her curriculum undertakes to research on **"COMPARATIVE EVALUATION OF REMAINING DENTINAL THICKNESS AFTER PROTAPER NEXT, NEOENDO FLEX, MTWO ROTARY FILES PREPARATION USING CBCT- AN IN VITRO STUDY."**for which purpose the Principal Investigator shall act as principal investigator and the college shall provide the requisite infrastructure based on availability and also provide facility to the PG student as to the extent possible as a Co-investigator.

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This is to certify that this dissertation work titled **"Comparative evaluation of remaining dentinal thickness after ProTaper NEXT, Neo endo Flex, MTtwo rotary files preparation using CBCT- an In Vitro study"** of the candidate **Dr.M.Assmee** with registration Number **241517002** for the award of **M.D.S- Conservative Dentistry and Endodontics in the branch of IV**. I personally verified the urkund.com website for the purpose of plagiarism Check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows **0 percentage** of plagiarism in the dissertation.

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ABSTRACT

AIM: The aim of this in-vitro study is to compare the remaining dentinal thickness in the mesio-buccal root of mandibular first molar at coronal, middle and apical third using three different rotary instrumentation techniques using Cone Beam Computed Tomography (CBCT).

MATERIALS AND METHODS: 30 freshly extracted mandibular first molar samples with less than 20 degree curvature were used in this study. The samples were divided into three groups- GROUP 1: ProTaper NEXT (PTN) (n=10), GROUP 2: Neoendo Flex file (n=10), GROUP 3: MTwo file (n=10). CBCT was taken to determine the dentinal thickness of the root canal before and after instrumentation. The teeth were scanned at coronal, middle, apical third of the canal in an axial slice thickness of 0.1mm. The values were recorded in the computer. Remaining dentin thickness was expressed in Percentage Remaining Dentin Thickness **(PRDT)** and was measured and analysed before and after instrumentation with three instrument groups.

RESULTS: There were statistically significant difference in retaining mean percentage remaining dentinal thickness in Neoendo Flex group (72.41±14.22) in middle third of the teeth when compared to ProTaper NEXT (54.72±14.37) with the p value of <0.05 but not with MTwo group (71.65±18.63). Also, MTwo group has the advantage of retaining dentinal thickness at apical third of teeth when compared to other two instruments and this was statistically highly significant with the p value $=0.000$. There was no significance among three groups in retaining thickness at coronal third. MTwo group was equally effective in retaining dentine thickness at all the three different locations ($p>0.05$).

CONCLUSION: From this study we concluded that MTwo has the advantage of retaining dentin thickness at all locations but more significantly in apical part when compared to ProTaper NEXT and Neoendo Flex file systems. Though Neoendo Flex file system was recently introduced in the field of endodontics, its effectiveness should be evaluated further in terms of retaining dentin thickness.

KEY WORDS: Mandibular first molar, Root Dentin thickness, Percentage Remaining Dentin Thickness (PRDT), Cone Beam Computed Tomography (CBCT), ProTaper NEXT, Neoendo Flex, MTwo.

CONTENTS

ABBREVIATIONS USED

CBCT	Cone Beam Computed Tomography
PRDT	Percentage Remaining Dentin Thickness
PRDT-COR	Percentage Remaining Dentin Thickness-Coronal third
PRDT-MID	Percentage Remaining Dentin Thickness- Middle third
PRDT-API	Percentage Remaining Dentin Thickness- Apical third
PTN	ProTaper Next
ANOVA	Analysis Of Variance
SPSS	Statistical Package for Social Sciences

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Introduction

For a successful endodontic outcome cleaning and shaping of the root canal system is mandatory. This procedure involves the removal of pulp tissue, pathogenic microorganisms, necrotized dentin and its debris from the root canal space.[61] This helps to achieve the three dimensional fluid tight seal of the root canal. One of the most important steps during endodontic treatment is cleaning and shaping. Every endodontist have a challenge to bring an optimal cleaning and shaping of the root canal system**.**[47]

Residual dentin thickness designate the instrumentation limits mechanically, to widen the root canal diameter, to predetermined values that would not weaken the root remarkably.[80] But after instrumentation, the original shape of the canal has to be preserved for a better endodontic treatment outcome. The remaining dentin thickness after the root canal procedure is directly related to the strength of the root and the thickness of the dentinal wall at the root circumference is critical.Direct correlation between the root thickness and the ability of the tooth to resist lateral forces and avoid fracture[58] , so the thinner the dentin, the more likely the tooth is to fracture[63] .

Any false presumption regarding the root canal wall thickness may lead to complications like strip perforation and vertical root fracture. These are all the possible consequences due to removal of excess dentin from the root canal wall.[72] Some authors recommended to flare the coronal third of the root canal to allow better access further into the middle and apical areas. [13, 66]Nevertheless, too much flaring reduces the fracture resistance of the root that results in likelihood of stripping and vertical root fracture.

Traditionally root canal shaping was done using 0.02 tapered stainless steel instruments. K-type files and reamers are used in a linear filing and rotational motion. Preparation sequence for traditional hand instrumentation involved determining working length radiographically followed by preparation of the root canal from apical constriction to orifice. But in case of curved canals these stainless steel files become inflexible and have a tendency to straighten causing deviation from the original shape of the canal resulting in increased removal of dentin on the outer wall in the apical region (zipping,ledging) and along the inner wall more coronally (Danger zone)**,**particularly at the start of canal curvature.[21]

Ni-Ti rotary instruments introduced in the field of endodontics has dramatically changed the way of root canal preparation since it has super elastic and shape memory properties as well as it is highly resistant to corrosion.[53]

Ni-Ti rotary instruments replaced the traditional hand files, since it reduces the time for biomechanical preparation, enhances the shaping ability of the root canal, reduce the clinical mishaps like ledges, transportations and perforations.[17]

ProTaper NEXT (Dentsply Maillefer) is a recently introduced file system are manufactured from M-Wire, that contributes towards more flexible instruments, increased safety and protection against instrument fracture (Gutmann, Gao, 2012)[32]helps the clinician to deal with more complex root canal systems with a higher success rate. The instrument has a bilateral symmetrical rectangular cross section with an off-centered axis of rotation, thus, creating an asymmetric rotary motion.

Van der Vyver and Scianamblo (2014)[76],described benefits of this design,(i)it reduces engagement between the instrument and canal wall due to two point contact at any time. It has a snake like swaggering (asymmetric) rotary motion as it advances inside the canal . This creates an enlarged space for debris removal, optimizes the canal tracking and reduces the binding. The pitch length increases from the tip to the shaft. This design feature may have an impact on the screwing effect, intra-operative torque values and the cleaning ability of the instruments.

Totally five ProTaper NEXT instruments are available in sizes 17, .04(X1) taper, size 25, .06 taper(X2), size 30, .07 taper(X3), size 40, .06 taper(X5), and size 50, .06 (X6)taper. However, it has to be taken into consideration that the given taper is not constant but all files have a variable taper along their working part.

Neoendo Flex file is a 3rd Generation Rotary File with 2 Files Shaping System undergone Gold Thermal Treatment renders it extremely flexible. It is available in various sizes and tapers of about 4%17, 4%20, 4% 25,6% 20,6% 25,6% 30,6% 35,4% 40 and coronal flaring file 30,8%.

Neoendo Flex Files also provides the better cyclic fatigue resistance. Cutting efficiency will be increased with the triangular cross section with sharp cutting edges of these files. Safety tip which is non cutting avoids accidental apical transportation and also provides extreme flexibility of this canal favours negotiation of any canal.

These Neoendo Flex Files has undergone specialized heat treatment process which gives them the unique flexibility characteristics and flutes do not open up when stress levels are reached, yet the file does not present shape memory. The golden colour of the file is a result of a very sophisticated and technologically advanced surface treatment to achieve a far superior cutting efficiency.[35]

Mtwo (VDW, Munich, Germany) rotary endodontic instrument has been introduced in 2003. Mtwo have an *Italic* ***S***-shaped cross-sectional design and a non-cutting safety tip and characterized by a positive rake angle with two cutting edges, which cuts the dentine effectively. Moreover, Mtwo instruments have an increasing pitch length from the tip to the shaft results in reduced fracture rate. This design is alleged to have two functions: (i) to eliminate threading and binding in continuous rotation, and (ii) to reduce the transportation of debris towards the apex. It is available as four instruments with variable tip sizes ranging from #10 to #25 and tapers ranging from 0.04 to 0.06–0.07. Mtwo NiTi instruments can be used without early coronal enlargement. Due to high flexibility and fatigue resistance of the file, the canal curvature is preserved.[41, 53]

Abou rass M et al (1982)[1] concluded that, most of the strip perforation would occur in the distal walls of the mesial root of mandibular first molar and proximal walls of buccal roots of maxillary molars. Stripping is the lateral perforation due to an over instrumentation in the thinner wall of the root. He referred this area as **"Danger zone".** In order to overcome these mishaps, he introduced a technique called **"anticurvature filing".**

Minimum of one millimetre of root dentin must remain in all aspects of root in order to prevent root fracture after intra-radicular procedures.[6] Also deviation from the main canal leads to inadvertent removal of root dentin, leading to straightening of the canal and ledge formation. This causes weakening of the tooth and reduces the resistance of the root to fracture.

To investigate the efficacy of instruments and technique for root canal preparation, a number of methods have been used to compare canal shape before and after preparation. Some of the methods are radiography, stereomicroscopic imaging, Computed Tomography, Cone Beam Computed Tomography, Micro-computed Tomography. Radiography only provides a 2-dimensional image of 3-dimensional object, and a cross section of the root canal is impossible to observe. The serial sectioning method is a commonly used method but this technique requires a complicated setup and a physical sectioning of the teeth before preparation can result in unknown tissue changes and loss of material. RDT can also be measured using Micro CT, but it is a slow and expensive process that is not always readily available.

Among different methods described in the literature for the evaluation of shaping ability of various instruments and preparation techniques, CBCT imaging is non destructive and is one of the latest innovations that provide cross section and detailed three-dimensional observations at a low radiation dose. In addition because of the possibility of choosing smaller field of view (FOV) compared to the medical CT scans, the resulting images have higher resolutions, and therefore are more accurate and have a higher diagnostic capability.[17]

Hence residual dentin thickness is essential for longevity of the tooth by providing resistance to the obturation forces as well as to the functional forces.[71]

The present In-vitro study, aimed to explore the effectiveness of newer rotary file systems (ProTaper NEXT, Neoendo Flex, MTwo) in preserving the remaining dentin thickness using CBCT.

Aim and Objectives

AIM AND OBJECTIVES

AIM:

The aim of the study is to compare the remaining dentinal thickness in the mesio-buccal root of mandibular first molar at coronal, middle and apical third using three different rotary instrumentation techniques using CBCT.

OBJECTIVES:

1. To evaluate the remaining dentin thickness after instrumentation using PROTAPER NEXT.
2. To evaluate the remaining dentin thickness after instrumentation using NEO ENDO FLEX FILE
3. To evaluate the remaining dentin thickness after instrumentation using M-TWO.
4. To compare the remaining dentin thickness between the three rotary files (ProTaper NEXT, Neoendo Flex & MTwo).

Review of literature

Cleaning and shaping of root canal system is a very important process for the successful outcome in endodontics. Procedures that involves the removal of pathogenic contents, such as pulp tissue, microorganisms, necrotic dentin and debris from the root canal system and attain a uniform taper to facilitate the obliteration of the prepared canal space.[61]

Remaining dentin thickness:

Remaining dentin thickness is important factor for preventing root fractures particularly vertical root fracture and thus remaining dentin thickness offers fracture resistance of the root.[75]

The distal walls of mesial roots of mandibular molars or on the proximal walls of the buccal roots of maxillary molars which are the most vulnerable areas where most of the perforations and strippings happened. This area of stripping and perforation is popularly known as ‘danger zone’.

Abou Rass M et al (1982)[1] introduced a new technique to maintain the integrity of root canal walls and that technique is called ‘anticurvature filing’. This will reduces the occurrence of root perforation and stripping.

Flaring the canal with larger files in order to allow instrumentation, decreases the dentin thickness which will resulting in reduction of remaining dentin thickness. This in turn increases the possibility of vertical root fracture.[1]

Excessive or inappropriate dentin removal will occur if instrumentation deviates from original curvature. This will also straighten the canal and creates a ledge in the wall of dentin and thus producing a biomechanical defect known as elbow. Elbow forms the coronal to the elliptical-shaped apical seal, which in turn requires stripping and over-preparation of tooth which will weakens the tooth, and resulting in fracture of the root. Thus, the remaining dentin thickness is important to resist from fracture.[31]

Lim SS & Stock CJR (1987)[43] suggested 0.3 mm of dentin should remain after canal preparation in order to provide the resistance against lateral forces and occlusal forces.

Glossen CR et al (1995)[29] compared root canals prepared by Nickel-Nitanium (Ni-Ti) hand, NiTi engine-driven, and stainless steel hand endodontic instruments using a modified Bramante technique and a digital subtraction software and reported that Engine-driven Ni-Ti instruments and hand instrumentation with the Canal Master "U" caused significantly less canal transportation, more centering ability , less dentin removal, and produced rounder canal preparations than K-Flex and NiTi hand files

Chan AW & Cheung GS (1996)[18] reported that after the introduction of instruments made of Nickel-Titanium has permitted the development of rotary instrumentation. This mainly because of Nickel-Titanium is two to three times more flexible than stainless steel and also provides considerably more resistant to clockwise torsional stress. Nickle-titanium (Ni-Ti) files also leave a thick layer of dentin than stainless steel which was advantageous.

Thompson SA & Dummer PM (1997)[73] conducted a study to determine the shaping ability of ProFile.04 Taper Series 29 rotary nickel titanium instruments in simulated canals & concluded that the canals were prepared without creating zip perforations or danger zone. Also ProFile Nickel-Titanium instruments removed more material from the outer aspect of the canal along the curve, in contrast to the pattern of preparation with stainless steel instrument.

Kum KY et al (2000)[40] compared the shaping ability of three ProFile rotary instrumentation techniques and a conventional step-back method in simulated root canals and reported that were no significant differences between the three rotary groups in preparation time, change in working length, and the incidence of aberrations.

Garip Y & Gunday M (2001)[27] compared root canal preparations using H and K-files made of Nickel–Titanium (Ni–Ti) and stainless steel (SS) and concluded that Ni–Ti instruments produced adequate foraminal enlargement, less canal transportation, and a better canal centering ability.

Garala M et al (2003)[26] compared the remaining canal wall thickness following Ni-Ti rotary system and they concluded that Ni-Ti rotary system led to lower possibility of instrument fracture which also an important factor for better results and thus offers a safe alternative for the treatment of canals with an accentuated curvature.

Sathorn C et al (2005)[63] conducted a study to determine fracture susceptibility and pattern with various factors like canal size, radius of curvature and proximal root concavity. They concluded that remaining dentin thickness not the only determining factor to resist fracture.

Shahriari S et al (2009)[68] concluded that Ni-Ti rotary ProFile instruments have removed less dentin in all dimensions when compared with that of SS hand instruments and in mesial direction at the apical zone as well as in distal and buccal directions in the mid-root there was a significant changes observed between the two groups.

Akhlaghi NM et al (2010)[2] claimed that pre-instrumentation thickness of the canal wall appears to be the most significant factor which will determines the post instrumentation canal wall thickness.

Nagaraja S & Sreenivasa Murthy BV (2010)[51] compared canal transportation, remaining dentine thickness, centering ability between hand NiTi K files and ProTaper rotary NiTi instruments using Computed Tomography (CT) & reported that hand NiTi K files produced lesser canal transportation and maintained greater dentine thickness at middle and coronal third and this difference was statistically significant.

Tabrizizadeh M et al (2010)[72] **conducted a** study to measure the thickness of root walls in the danger zone in mandibular first molars and reported that the mean thickness in the distal portion of the mesial root was smaller in comparison to all other portions of the roots with the mean thickness being 1.2mm.

Rao MS et al (2013)[61] conducted an in vitro Study to compare the Remaining Dentin Thickness in the Root after Hand and Four Rotary Instrumentation Techniques. They used ProTaper, light speed LSX, K3 and M2 and to compare with that of K-files. They concluded in the study that all the six instrumentation techniques used in this study had removed almost equal amount of dentin apically.

ProTaper Next:

The ProTaper NEXT (PTN) System provides shaping advantages through the convergence of a variable tapered design on a given file (ProTaper Universal), innovative M-Wire technology, and a unique offset mass of rotation.

There are 5 PTN files available, in different lengths, for shaping canals, namely X1, X2, X3, X4, and X5. In sequence, these files have yellow, red, blue, double black, and double yellow identification rings on their handles, corresponding to sizes 17/04, 25/06, 30/07, 40/06, and 50/06, respectively.

Advantages includes progressively percentage tapered design on a single file, employing M-Wire technology and Offset mass of rotation.

Erika S.J.Pereira et al (2013)[23] assessed the torque and force generated by Novel ProTaper NEXT Instruments during Simulated Canal Preparation In Vitro. Results showed that Significant differences in peak torque ($P < .0001$), positive force ($P < .002$), and negative force ($P < .0001$) were found for ProTaper Next instruments overall.

A.M Elnaghy & Elaska E (2014)[5] carried out a study to Assess the Mechanical Properties mainly torsional resistance, flexibility, and surface microhardness of ProTaper NEXT, Nickel-Titanium Rotary Files and the study results revealed that ProTaper NEXT has associated with highest torsional resistance and microhardness, followed by RC ($P < .05$) which was a significant one. They also concluded that PTN improved its resistance to torsional stresses and wear compared with Twisted Files (TF) and RaCe (RC).

Arias A et al (2014)[9] studied the peak torque and force induced by ProTaper Universal (PTU) and ProTaper NEXT (PTN) instruments while preparing small and large root canals and concluded that ProTaper Next (PTN) when compared with ProTaper Universal (PTU) produced greater regularity in peak torque.

Elnaghy AM (2014)[22] studied the cyclic fatigue resistance of ProTaper Next files with Twisted files and ProTaper Universal (PT; Dentsply Maillefer) and they obtained the results showing a significantly higher resistance to cyclic fatigue in that Twisted Files than the other instruments (P value less than 0.05). They concluded that the new ProTaper NEXT when compared with ProTaper and HyFlex CM had greater resistance to cyclic fatigue but not the Twisted Files.

Perez-Higueras JJ et al (2014)[56] with the aim of comparing cyclic fatigue resistance of ProTaper universal and ProTaper Next instruments at different points of curvature and concluded that PTN files were significantly more resistant to CF than PTU instruments at all the other tested levels.

Burklein S et al (2015)[15] compared the shaping ability of BT-RaCe and ProTaper NEXT Nickel –Titanium instruments during the preparation of curved root canals and study results showed Instrumentation with ProTaper NEXT files was faster than with all other instruments used in this study ($P < 0.05$) and they concluded that all the file system used in this study well maintained the canal curvature and also they were safe.

Gagliardi J et al (2015)[25] carried out a study to evaluate shaping characteristics of the Various ProTaper instruments that include ProTaper Gold, ProTaper NEXT, and ProTaper Universal in curved canals using Micro–Computed Tomographic imaging and the following conclusions were made, a) ProTaper Gold, ProTaper NEXT has produced less transportation and they maintained more dentin than ProTaper Universal. b) ProTaper NEXT had less canal wall contact than ProTaper Gold and ProTaper Universal c) all file systems were able to instrument moderately curved mesial root canals of mandibular molars without clinically significant errors.

Uygun AD et al (2016)[74] compared the cyclic fatigue resistance among various instruments like ProTaper Gold, ProTaper NEXT and ProTaper Universal and concluded that there was no difference between the ProTaper Gold, ProTaper NEXT instruments at 8mm level but 5 and 8 mm from the tip, ProTaper Gold showed more resistant than the others.

MTwo :

Mtwo (Mtwo ® , VDW, Munich, Germany) endodontic instruments are a new generation of NiTi rotary instruments recently introduced. The basic series of Mtwo instruments includes eight instruments, with tapers ranging between 0.04 and 0.07, and sizes from ISO 10 to 40.

They have an S-shaped cross sectional design with a non-cutting tip. The two cutting edges have a positive rake angle that will effectively cut the dentine. They also claimed to eliminate threading and binding in continuous rotation, and to reduce transportation of debris towards the apex. They also used to the full working length to shape the entire length of the canal.[41]

Foschi F et al (2004)[24] compared the root canal wall dentine following use of Mtwo and ProTaper NiTi rotary instruments using scanning electron microscopy (SEM) in vitro and they observed that both Mtwo and ProTaper NiTi rotary instruments clean and debris-free dentine surfaces in the coronal and middle thirds but not in the apical third because of the presence of deep grooves and depression on dentine walls in the apical third.

Burklein S & Schafer E (2006)[16] used the Mtwo rotary Nickel-Titanium instruments and compared the shaping ability of this instruments in simulated curved canals and in curved root canals of extracted teeth and concluded that Mtwo instruments with Mtwo direct handpiece is suitable for preparing curved root canals.

Plotino G et al (2006)[59] evaluated the cyclic fatigue between used and new Mtwo Ni-Ti rotary instruments after controlled clinical use in molar teeth and conclusion was made as follows after the results that when compared with an unused control group, clinical use significantly reduced cyclic fatigue resistance of Mtwo rotary instruments. But all the instruments had minimal instrument fatigue when discarded after controlled clinical use.

Schafer E et al (2006)[64] compared the cleaning effectiveness and shaping ability of rotary MTwo instruments during the preparation of curved root canals in extracted human teeth. Results showed that Mtwo instruments maintained the original canal curvature significantly better than the other instruments ($P < 0.05$). and also Instrumentation made with Mtwo files associated with significantly faster rate than with K3 or RaCe instruments ($P < 0.05$). They concluded that good cleaning and maintenance of original curvature significantly better for Mtwo files than K3 or RaCe files.

Schafer E & Oitzinger M (2008)[65] carried out a study to compare the cutting efficiency of the following rotary Nickel-Titanium instruments namely Alpha-File, FlexMaster, Mtwo, ProFile, and RaCe files and they found out that greatest cutting efficiency were displayed by Mtwo and RaCe files than the others.

Inan U & Gonulol N (2009)[37] evaluated the deformation and fracture rate of MTwo rotary Nickel-Titanium instruments which was discarded after routine clinical use and they have arrived at a conclusion that #10.04 and #15.05 files have the higher rate of deformation so these file system should be considered for single usage because cyclic fatigue was the cause of instrument fractures in more than 70% of cases.

Marfisi K et al (2010)[45] evaluated the efficacy of ProTaper Retreatment files, MTwo Retreatment files and Twisted Files to remove gutta-percha and Resilon from root canals. Their conclusion was when compared with other instruments MTwo Retreatment files required less time to remove root filling material. Irrespective of the instruments used , Resilon was removed significantly better from the canal walls than gutta-percha.

Azar M & Mokhtare M (2011)[10] compared the Efficacy in preparing primary and permanent molar root canals and preparation time of rotary instruments (MTwo) and conventional manual instruments (K-file). No significant differences between the K-file and MTwo rotary system in primary and permanent teeth regarding cleaning ability. They concluded that greater efficacy in terms of canal preparation and lesser canal preparation time was observed with Mtwo rotary system.

Lee MH et al (2011)[42] conducted a study to correlating cyclic fatigue fracture tests with finite-element analysis for Nickel-Titanium rotary files i.e ProTaper, ProFile, HeroShaper, and MTwo and the results showed that MTwo has the best cyclic fatigue resistance whereas ProTaper (the stiffest instrument) showed the least cyclic fatigue resistance and highest stress concentration for all tested curvatures and increased curvature of the root canal generated higher stresses and shortened the lifetime of NiTi files. They concluded that higher stresses was generated with increased curvature of the root canal and shortened the lifetime of NiTi files.

AlvesVde O et al (2012)[4] conducted a study to compare manual instruments and PathFile and MTwo rotary instruments in order to create a glide path in curved canals during root canal preparation. They concluded that none of the instruments used in this study had any influence on the occurrence of apical transportation and they also not produced any canal aberration.

Hin ES et al (2013)[34] observed the effects of self-adjusting file, MTwo, and ProTaper on the root canal wall. They concluded that self-adjusting file, MTwo, and ProTaper could cause damage to root canal dentin but self-adjusting file caused less damage when compared with the other files.

Cone Beam Computed Tomography as a tool to study root canal system :

Cone Beam Computed Tomography (CBCT) can be useful to dentists because that will give high-quality 3-dimensional images of dental structures since it has high spatial resolution. Cone Beam Computed Tomography (CBCT) can be used to give cross-sectional (cut plane) and three-dimensional (3D) images. These images are highly accurate and they are quantifiable also. CBCT, thus useful for evaluating remaining dentin thickness before and after instrumentation with various file system.

Gluskin AH et al (2001)[30] also evaluated the effects of preparation with Gates Glidden burs versus Nickel-Titanium GT rotary files with that of conventional stainless steel Flexofiles in the shaping of mesial root canals of extracted mandibular molars by using reconstructed computerized tomographic method.

Katz A & Tamse A (2003)[39] evaluated the remaining dentine thickness in mandibular incisors after various intracanal procedures by using combined radiographic and computerized scanning method with the aim of developing computerized model. They have studied the place, stage and location of dentine thickness affected after various intra canal procedures by using the computerized model.

Mahran AH & AboEl-Fotouh MM (2008)[44] compared the effects of 3 different instruments namely ProTaper, HeroShaper, and Gates Glidden Burs after they were used to prepare curved root canals on the remaining cervical dentin thickness. They also studied total amount of dentin removed from root canals during instrumentation with these instruments by using multislice Computed Tomography.

Matherne RP et al (2008)[46] investigated the use of Cone Beam Computed Tomography (CBCT) as a diagnostic tool for identifying root canal systems (RCSs) in vitro. They compared the images of CBCT with that of charged coupled device (CCD) and photo stimulable phosphor plate (PSP) digital radiography. They have concluded that CCD or PSP methods failed to identify at least 1 RCS in approximately 4 of 10 teeth when compared with that of CBCT.

Baratto Filho F et al (2009)[12] investigated internal morphology of maxillary first molars by ex vivo, clinical, and Cone Beam Computed Tomography (CBCT) methods and they have come to the conclusion that CBCT can be used as a good method for initial identification of internal morphology of maxillary first molar.

Patel S et al (2009)[55] studied the newer dimensions in imaging techniques in endodontics and they have convinced that exact location and anatomy of the root canal system can be easily assessed with CBCT than conventional imaging methods.

Michetti J et al (2010)[48] Validated the use of Cone Beam Computed Tomography as a Tool to Explore Root Canal Anatomy when compared with that of histologic sections. Their findings showed that strong to very strong correlation was obtained between the data acquired by using CBCT and histology.

Neelakantan P et al (2010)[52] investigated the root and canal morphology of maxillary first and second molars in an Indian population by using Cone Beam Computed Tomography (CBCT). They concluded that CBCT is clinically useful tool to study canal and root morphology.

Akhlaghi NM et al (2014)[3] evaluated of residual root thickness after pre-flaring using gates Glidden drills by using Computed Tomography because of its non-invasive nature and the ability to study the root canal preparations.

Anil Dhingra & Deepika Parimoo (2014)[7] by using CBCT, have evaluated the dentine thickness after instrumentation with Wave One file system and One Shape file system in the apical area of the root canal since CBCT emits less radiation dose than conventional one and also producing superior quality images(3D) of the maxillo-facial skeleton.

Ramanathan S & Solete P (2015)[60] conducted an in vitro study in Chennai and evaluated the remaining dentin thickness of teeth, instrumentation with three rotary instruments after cleaning and shaping the canal. They evaluated the thickness using Cone Beam Computed Tomography (CBCT). With CBCT evaluation of remaining dentin thickness, they have concluded that ProTaper Universal and ProTaper NEXT should be used cautiously bacause they causes higher thinning of root dentin of the root when compared with Mtwo.

Anil K Tomer et al (2017)[8] also supported the use of CBCT for evaluation of residual dentine thickness. They have carried out a study to compare dentine thickness using different file system and evaluation of thickness was carried out by CBCT imaging.

Materials and Methods

MATERIALS AND METHODS

MATERIALS:(Fig-2)

- 3% sodium hypochlorite solution (Septodont)
- 17% EDTA solution (Endoprep-Rc ,Anabond Stedman)
- Normal Saline solution(0.9%)
- Clear acrylic resin (DPI-RR Cold cure resin)

ARMAMENTARIUM:(Fig-3)

- Diamond disc
- Aluminium mold (3cm length,1cm width,1cmheight)
- Airotor hand piece (NSK,japan)
- Stainless steel hand K- file #10,#15, #20 (Dentsply-Maillefer, Switzerland)
- X smart rotary motor with hand piece (Dentsply-Maillefer, Switzerland)
- ProTaper NEXT files (Dentsply-Maillefer, Switzerland)
- Neoendo Flex files (Oricam)
- MTwo (VDW,Munich,Germany)
- Endoblock (Dentsply-Maillefer, Switzerland)
- Disposable syringe (2cc,27 gauge, Unilock)

EQUIPMENT USED:

- **Cone Beam Computed Tomography (CBCT)**

  -CARESTREAM: CS9300C

METHODOLOGY:

Selection of teeth:

A thirty (30) freshly extracted mandibular first molar teeth were collected from the department of Oral and Maxillofacial Surgery, Tamilnadu Government Dental College and Hospital, Chennai.

Criteria for selection of teeth were:

Inclusion criteria:

1. Free of caries.
2. Free of cracks
3. Free of restorations.
4. Completely formed root apices.
5. Curved root canal with angle of curvature less than 20 degree selected by schneider's method.

Exclusion criteria:

1. Calcified canals.

2. Root canals with double or more curvatures

3. Curvature more than 20 degree.

PREPARATION OF SPECIMENS:(Fig-1a&1b)

The thirty freshly extracted human mandibular first molars were selected as per above mentioned inclusion criteria. The teeth were cleaned free of debris and calculus and then were stored in 10% buffered formalin solution in order to maintain the physiological characteristics of the teeth.

All the teeth were de-coronated at the level of CEJ using a diamond disc and mesial roots were separated from distal roots and the mesio-buccal canal is taken for instrumentation. The root length of the specimens was standardized to a length of about 12mm. A patency 10 size stainless steel hand K- file was passively introduced into the canal until it became visible at the apical foramen and the working length (WL) was established 0.5mm short of this length. All the specimens were taken and embedded into clear acrylic resin (Fig-4&5), which was placed in an aluminium mold measuring 3cm length, 1cm width, 1cm height. The thirty specimens were randomly divided into three experimental groups containing 10 teeth each namely.

GROUP 1 :ProTaper NEXT (n=10):

GROUP 2 :Neoendo Flex file (n=10):

GROUP 3: MTwo file (n=10)

All the teeth were scanned using a Cone Beam Computed Tomography (84Kvp, 5.0mA, 90mmVoxel, and Exposure time-20 sec, Effective dose-598microseivert) (Fig-7) to determine the dentinal thickness of the root canal before instrumentation. The teeth were scanned at 3mm, 7mm and 12mm from the apex of the canal in an axial slice thickness of 0.1mm (Fig-8). The values were recorded in the computer.

After initial scanning, all the root canals were negotiated and enlarged up to 20 size stainless steel hand K file. Throughout the instrumentation procedure, irrigation of the root canals was done alternatively with 3% NaOCl and 17% EDTA.

GROUP 1 :ProTaper NEXT

The root canals were prepared using rotary Ni-Ti ProTaper NEXT files using following steps:

The shaping procedure was commenced with SX ProTaper file for coronal shaping. This was followed by ProTaper NEXT X1, X2 upto the Working length used with a pecking motion (Fig-6a).

GROUP 2 :Neoendo Flex:

In this group root canals were prepared using rotary Ni-Ti Neoendo flex files using following steps:

The shaping procedure commenced with a Neoendo coronal flaring file size 30 taper 0.08. and the coronal one third of the root canal was shaped. Then Neoendo file size 20 taper 0.04 was inserted and used upto the working length. Shaping was continued with Neoendo file size 25 taper 0.04 followed by size 20 taper 0.06. Final apical preparation was standardized to 0.06 taper, sizes 25 (Fig-6b).

GROUP 3 : MTwo

In this group root canals were prepared using rotary Ni-Ti MTwo files using following steps:

The shaping procedure commenced with a MTwo file size 15 taper 0.06 up to the working length. This was followed by size 20 taper 0.06 and final preparation was done using size 25 taper 0.06 (Fig-6c)

All the instrumented teeth were then scanned with CBCT under the same position and parameters as the initial scans were recorded and the values were noted in the computer and Percentage remaining dentin thickness was calculated using the formula given below:

Percentage Remaining Dentin Thickness (PRDT):

$$\textbf{PRDT} = \frac{\text{Post- instrumentation thickness}}{\text{Pre- instrumentation thickness}} \times 100$$

PRDT calculated for all the rotary instruments at three different portions of the root were tabulated and analyzed statistically using SPSS-Version 22 (IBM Corp).

Data were assessed for normality using Shapiro Wilk test and found to be normally distributed. One way ANOVA followed by Tukey multiple comparison test was used to know the significance among all the rotary groups as well as among three different portions of the root canal within the same rotary group.

PROCEDURAL FLOW CHART FOR SPECIMEN PREPERATION

30 freshly extracted human mandibular first molar

↓

Removal of debris &calculus

↓

Stored in 10% buffered formalin

↓

Decoronation done at CEJ level using diamond disc

↓

Mesial root sectioned from distal root &mesio-buccal canal taken for instrumentaion

↓

Root canal curvature assessed by schneider's method & canals <20 degree were selected

↓

Standardization of root length for about 12mm

↓

Patency done using 10 size K file untill the file was visible at the apical foramen.

↓

Working length established 0.5 mm short of length.

↓

Specimen mounted in an acrylic block.

PROCEDURAL FLOW CHART FOR CBCT SCANNING

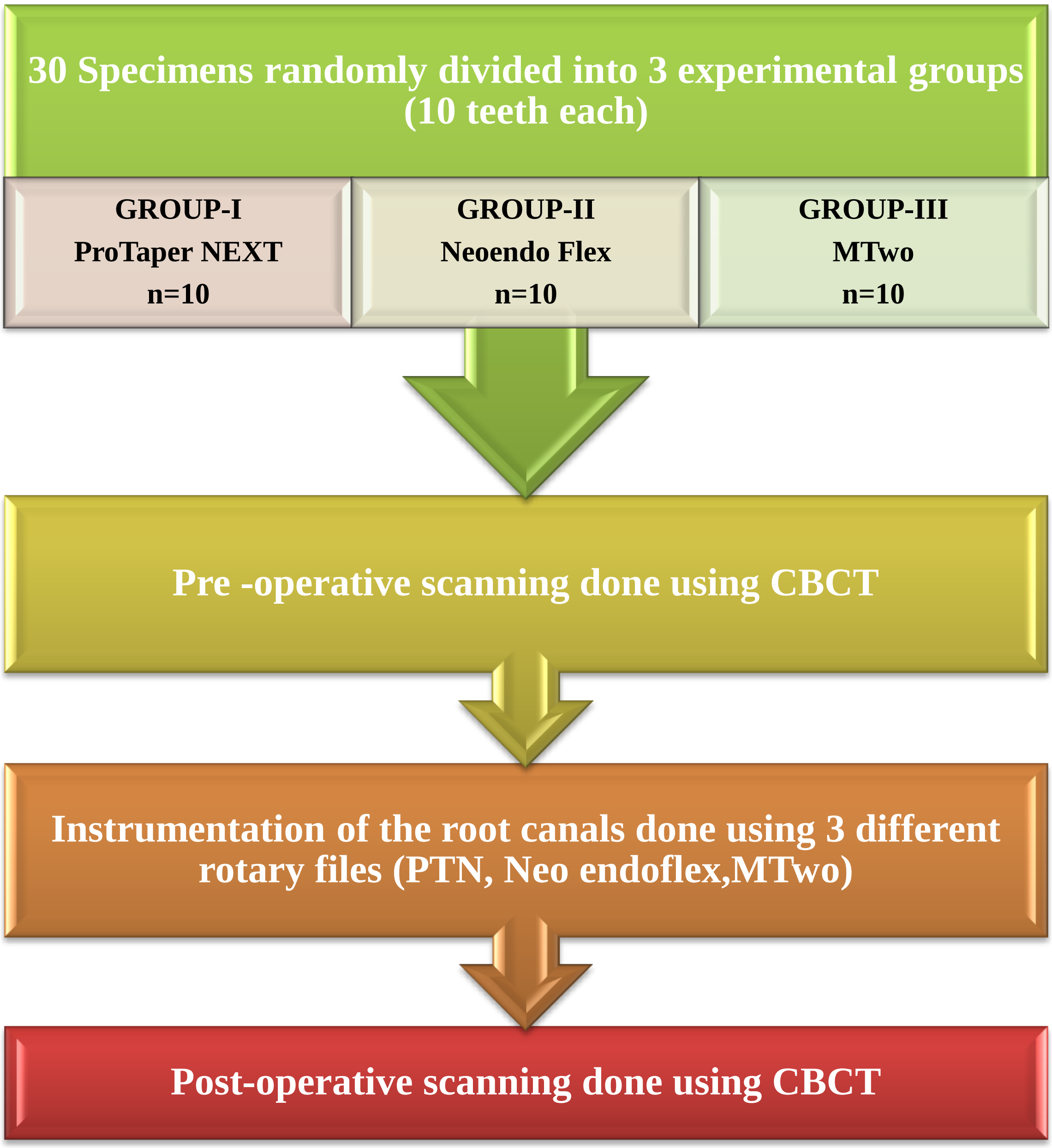


Fig-1: SPECIMEN PREPARATION

Fig 1a: Tooth preparation

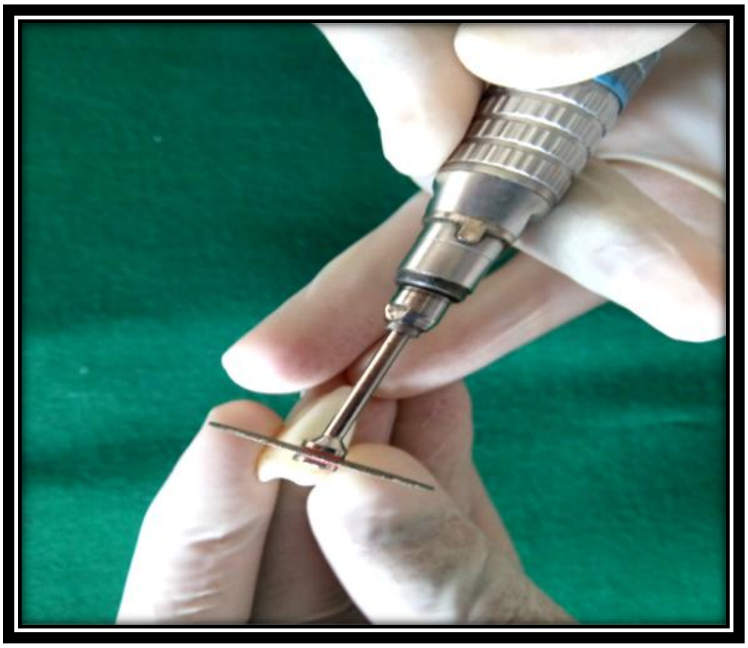


Fig 1b: Tooth preparation

Fig -2: MATERIALS

Fig -3: ARMAMENTARIUM

Fig 4: Specimens mounted for canal curvature assessment in CBCT :

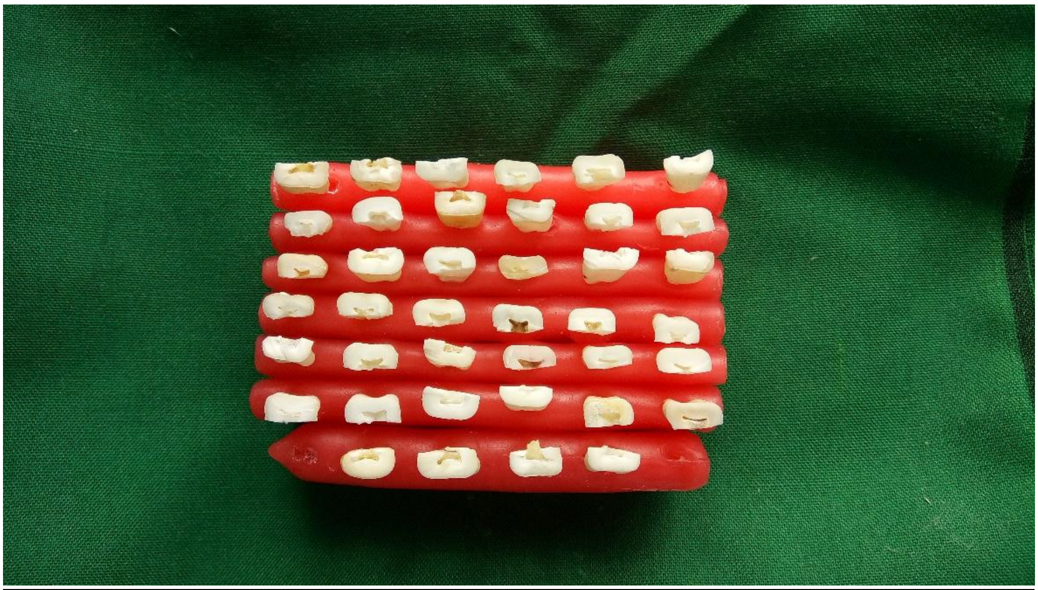


Fig 5: Specimens mounted in an acrylic model :

Fig 6: BIOMECHANICAL PREPARATION OF ROOT CANAL

Fig 6a: GROUP-I

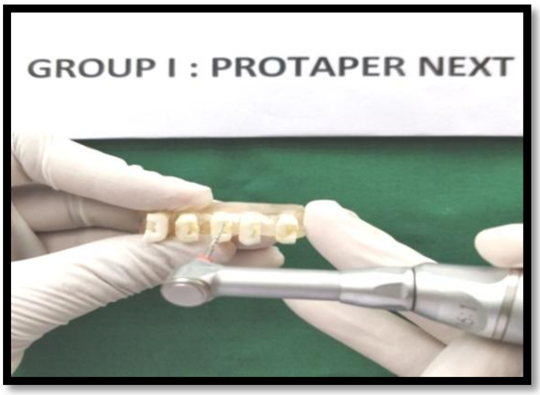


Fig 6b: GROUP-II

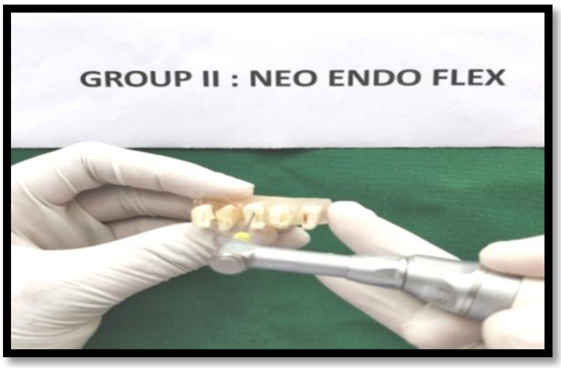


Fig 6c: GROUP-III

Fig 7: CONE BEAM COMPUTED TOMOGRAPHY:

Fig 8: CBCT IMAGING OF SPECIMEN:

Results

Results

Root Dentin Thickness measured before and after instrumentation for each specimen:

Table -1: Dentine thickness by pre and post instrumentation and by locations

Group	Sample number	Pre instrumentation (mm)			Post instrumentation (mm)		
		coronal	Middle	apical	coronal	Middle	Apical
Group-I PROTAPER NEXT	1	1	1	0.7	0.9	0.3	0.3
	2	1.3	0.9	0.9	0.5	0.5	0.4
	3	1	0.9	0.9	0.7	0.4	0.2
	4	0.9	0.8	0.6	0.7	0.5	0.5
	5	1.2	1	0.8	0.8	0.4	0.4
	6	1.1	0.9	0.8	0.8	0.5	0.3
	7	1.3	0.8	0.8	1	0.5	0.5
	8	0.7	1	1.2	0.6	0.8	0.5
	9	1.3	1	1.1	0.6	0.5	0.4
	10	1.2	0.9	1	0.5	0.6	0.5
Group-II NEOENDO FLEX	1	1.1	0.9	0.7	0.9	0.5	0.5
	2	0.9	1	0.7	0.6	0.6	0.4
	3	0.9	0.8	0.8	0.7	0.5	0.3
	4	1.4	0.8	0.9	1	0.6	0.5
	5	0.9	0.9	0.8	0.6	0.7	0.5
	6	0.9	0.9	0.6	0.7	0.6	0.3
	7	0.7	0.9	0.8	0.5	0.7	0.3
	8	0.8	0.9	0.7	0.6	0.8	0.4
	9	1.3	0.8	0.9	1.1	0.6	0.5
	10	1	1	1	0.6	0.6	0.4
Group-III MTWO	1	1.5	1	0.8	1.2	0.6	0.6
	2	1.4	0.9	0.9	1.2	0.8	0.9
	3	1.3	1	0.9	1	0.9	0.8
	4	1.1	0.9	0.9	0.9	0.7	0.7
	5	1	1.2	1	0.8	0.6	0.8
	6	1	0.9	0.8	0.8	0.5	0.5
	7	1.2	1.1	0.8	0.9	0.6	0.6
	8	1	0.9	1	0.8	0.6	0.9
	9	1.3	1	0.9	1.1	0.6	0.6
	10	1.1	1.1	0.8	0.8	1	0.6

TABLE-2: PERCENTAGE REMAINING DENTINAL THICKNESS (PRDT):

GROUP	PRDT-CORONAL THIRD	PRDT-MIDDLE THIRD	PRDT-APICAL THIRD
PROTAPER NEXT (n=10)	90.00	30.00	42.86
	42.46	55.56	44.44
	70.00	44.44	22.22
	96.00	62.50	83.33
	66.67	40.00	50.00
	72.73	55.56	37.50
	76.92	62.50	62.50
	85.71	80.00	41.67
	46.15	50.00	36.36
	41.67	66.67	50.00
NEOENDO FLEX (n=10)	81.82	55.56	71.43
	66.67	60.00	57.14
	77.78	62.50	37.50
	71.43	75.00	55.56
	66.67	77.78	62.50
	77.78	66.67	50.00
	71.43	77.78	37.50
	75.00	88.89	57.14
	84.62	96.67	55.56
	60.00	63.33	40.00
MTWO (n=10)	80.00	60.00	77.00
	85.71	88.89	98.00
	76.92	90.00	88.89
	81.82	97.00	77.78
	80.00	53.00	80.00
	80.00	55.56	66.50
	75.00	54.55	75.00
	80.00	66.67	90.00
	84.62	60.00	88.89
	72.73	90.91	96.00

PRDT is calculated for the three rotary instrument groups namely ProTaper NEXT, Neoendo Flex and MTwo at three locations of teeth namely coronal third, middle third and apical third. PRDT is displayed in **Table 2.**

Test of normality was used to determine if a data set is well modeled by a normal distribution and to compute how likely it is for a random variable underlying the data set to be normally distributed.(Table-3).

Data were assessed for normality using **Shapiro Wilk test** and found to be normally distributed.

TABLE 3: TEST OF NORMALITY -Shapiro's Wilk's Test Of Normality:

ROTARY_TYPE	SHAPIRO-WILK TEST		
	STATISTIC	Df	Sig
PRDT_CORONAL			
PRO TAPER NEXT	.940	10	**0.552**
NEO-ENDO FLEX	.974	10	**0.928**
M-TWO	.947	10	**0.637**
PRDT_MIDDLE			
PRO TAPER NEXT	.988	10	**0.993**
NEO-ENDO FLEX	.924	10	**0.396**
M-TWO	.860	10	**0.077**
PRDT_APICAL			
PRO TAPER NEXT	.919	10	**0.347**
NEO-ENDO FLEX	.918	10	**0.339**
M-TWO	.943	10	**0.592**

Table 4 Explains the descriptive statistics for three rotary groups at three locations i.e mean PRDT, standard deviation and range.

TABLE 4: DESCRIPTIVE STATISTICS:

ROTARY TYPE	PRDT-CORONAL THIRD	PRDT-MIDDLE THIRD	PRDT-APICAL THIRD
PROTAPER NEXT			
Mean	**68.83**	**54.72**	**47.08**
Std. Deviation	**20.99**	**14.37**	**16.49**
N	10	10	10
Minimum	38.46	30.00	22.22
Median	71.36	55.55	43.65
Maximum	90.00	80.00	83.33
NEOENDO FLEX			
Mean	**73.31**	**72.41**	**52.43**
Std. Deviation	**7.56**	**14.22**	**11.21**
N	10	10	10
Minimum	60.00	55.55	37.50
Median	73.21	70.83	55.55
Maximum	84.61	96.00	71.42
MTWO			
Mean	**79.67**	**71.65**	**83.80**
Std. Deviation	**3.99**	**18.63**	**11.89**
N	10	10	10
Minimum	72.72	50.00	62.5
Median	80.00	63.33	84.44
Maximum	85.71	97.00	98.00

From the above **Table 4,** MTwo has the highest mean PRDT at apical third (83.80±11.89) as well as at coronal third (79.67±3.99) but in middle third Neoendo Flex file system has better mean PRDT when compared to other two file systems (mean PRDT of 72.41±14.22).

The one-way analysis of variance (ANOVA) was used to determine whether there are any statistically significant differences between the mean percentage of remaining dentin thickness after instrumentation with three rotary groups and the analysis by ANOVA test showed Significant difference among the groups.(Table-5)

Table-5: INTER GROUP COMPARISON- ANOVA TEST:

LOCATION		F	Sig
PRDT_CORONAL	**Between Groups**	1.735	.196
	Within Groups		
	Total		
PRDT_MIDDLE	**Between Groups**	3.970	**.031**
	Within Groups		
	Total		
PRDT_APICAL	**Between Groups**	21.885	**.000**
	Within Groups		
	Total		

From the ANOVA test, PRDT middle third and apical third showed significant results between three groups used in this study. **(p<0.05) (Table 5)**

Though there were significant results from ANOVA test obtained for middle and apical third we were not certain that which rotary system were responsible for this significance.

To analyze further, **Post Hoc test** was used to study the inter-group differences in retaining the dentinal thickness at different locations.

INFERENCE :

A Tukey post hoc test revealed that there were statistically significant difference in mean percentage remaining dentinal thickness among **Neoendo Flex group** (72.41±14.22) in **middle third** of the teeth when compared to ProTaper NEXT (Goup-I) (54.72±14.37) which was statistically significant ($p<0.05$) but not with MTwo (Group-III) (71.65±18.63) file system. ($p>0.05$) (Table-5a)

Also, MTwo group has the advantage of retaining dentinal thickness at apical third of teeth when compared to other two instruments and this was statistically highly significant with the p value =0.000. There was no significance among three groups in retaining thickness at coronal third. (Table-5a).

In the below figure also clearly demonstrate that MTwo has the advantage in retaining thickness at apical third when compared to other two groups (Graph-1).

GRAPH-1: INTERGROUP COMPARISON OF MEAN PRDT:

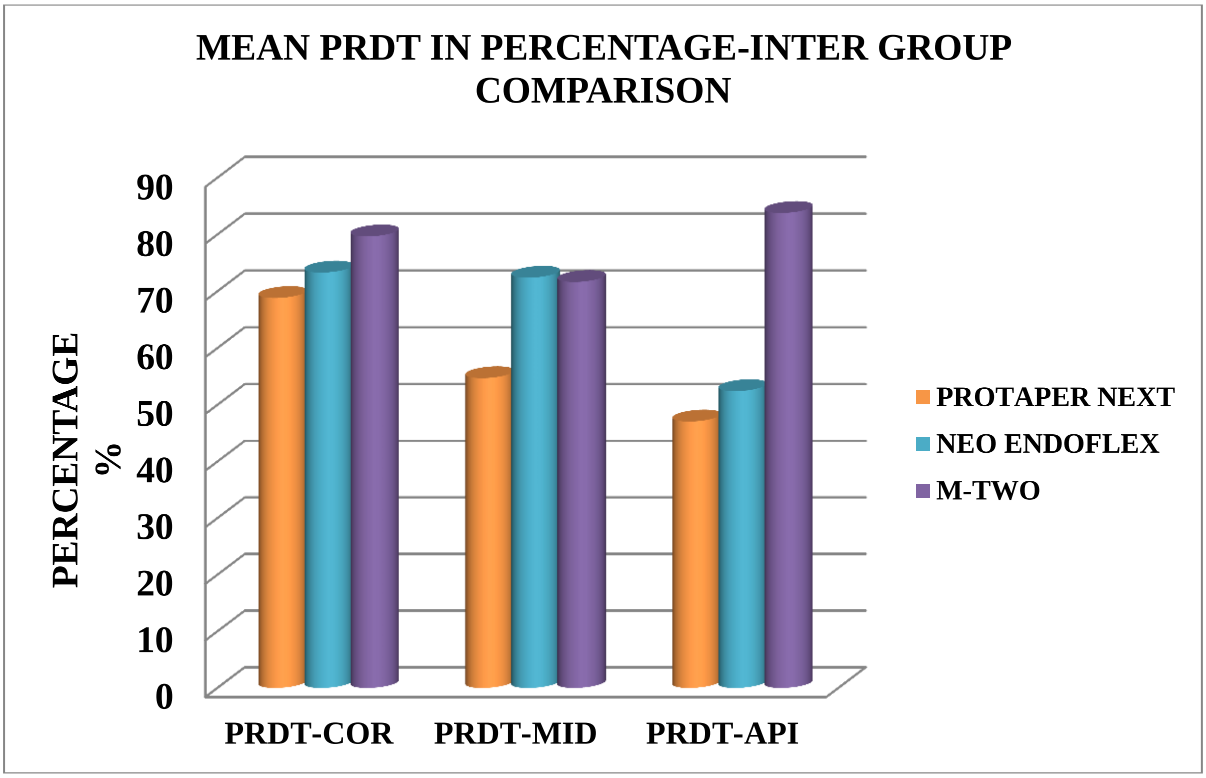


Table -5a: Inter group comparisons using Tukey HSD post hoc test:

Dependent variable	(I) ROTARY_TYPE	(J)ROTARY_ TYPE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
PRDT_ CORONAL	PRO TAPER NEXT	NEO-ENDO FLEX	-4.48	5.85	.726	-18.998	10.025
		M-TWO	-10.84	5.85	.172	-25.360	3.663
	NEO-ENDO FLEX	PRO TAPER NEXT	4.48	5.85	.726	-10.0256	18.998
		M-TWO	-6.36	5.85	.530	-20.874	8.150
	M-TWO	PRO TAPER NEXT	10.84	5.85	.172	-3.663	25.360
		NEO-ENDO FLEX	6.36	5.85	.530	-8.150	20.874
PRDT_ MIDDLE	PRO TAPER NEXT	NEO-ENDO FLEX	-17.69*	7.10	**.049**	-35.298	-.090
		M-TWO	-16.93	7.10	.061	-34.538	.669
	NEO-ENDO FLEX	PRO TAPER NEXT	17.69*	7.10	**.049**	.090	35.298
		M-TWO	.7597	7.10	.994	-16.844	18.363
	M-TWO	PRO TAPER NEXT	16.93	7.10	.061	-.669	34.538
		NEO-ENDO FLEX	-.7597	7.10	.994	-18.363	16.844
PRDT_ APICAL	PRO TAPER NEXT	NEO-ENDO FLEX	-5.34	5.99	.650	-20.212	9.524
		M-TWO	-36.71*	5.99	**.000**	-51.585	-21.848
	NEO-ENDO FLEX	PRO TAPER NEXT	5.34	5.99	.650	-9.524	20.212
		M-TWO	-31.37*	5.99	**.000**	-46.241	-16.504
	M-TWO	PRO TAPER NEXT	36.71*	5.99	**.000**	21.848	51.585
		NEO-ENDO FLEX	31.37*	5.99	**.000**	16.504	46.241

*. The mean difference is significant at the 0.05 level.

INTRA-GROUP COMPARISON:

To analyze the effectiveness of the three rotary groups to retain the dentine thickness at various distance i.e., coronal third, middle third and apical third , the intra group comparison by using ANOVA test carried out.Table 6 shows the intra group comparison of the three instruments used in this study.

The intra group analysis by ANOVA test revealed that there was highly significant difference in retaining thickness at various levels by ProTaper NEXT group (p=0.031) and Neoendo Flex group (p=0.000)

The MTwo group showed no significance (p>0.05) i.e., MTwo will equally affects the dentine thickness in all three locations.

TABLE-6: INTRAGROUP COMPARISON- ANOVA TEST:

		F	Sig.
PRDT_PROTAPER_NEXT	Between Groups	3.971	**.031**
	Within Groups		
	Total		
PRDT_NEO_ENDO	Between Groups	10.851	**.000**
	Within Groups		
	Total		
PRDT_M_TWO	Between Groups	2.268	.123
	Within Groups		
	Total		

To explore further post hoc test was used in order to differentiate the effectiveness of different instruments at three different locations and this test also confirms that MTwo group has almost equally effective in retaining dentine thickness at three different locations ($p>0.05$) (Table-6a).

INFERENCE:

From Table 6a & Fig-2 we can appreciate that Neoendo Flex group has significantly higher effectiveness in retaining dentin thickness at coronal (**73.31±7.56**) and middle third (**72.41±14.22**) when compared to apical third (**52.43±11.21**) ($p=0.001$).

It is also noted by this test that ProTaper NEXT is effective in retaining dentin thickness at coronal third when compared to apical third and this was found to be statistically significant ($p<0.05$).

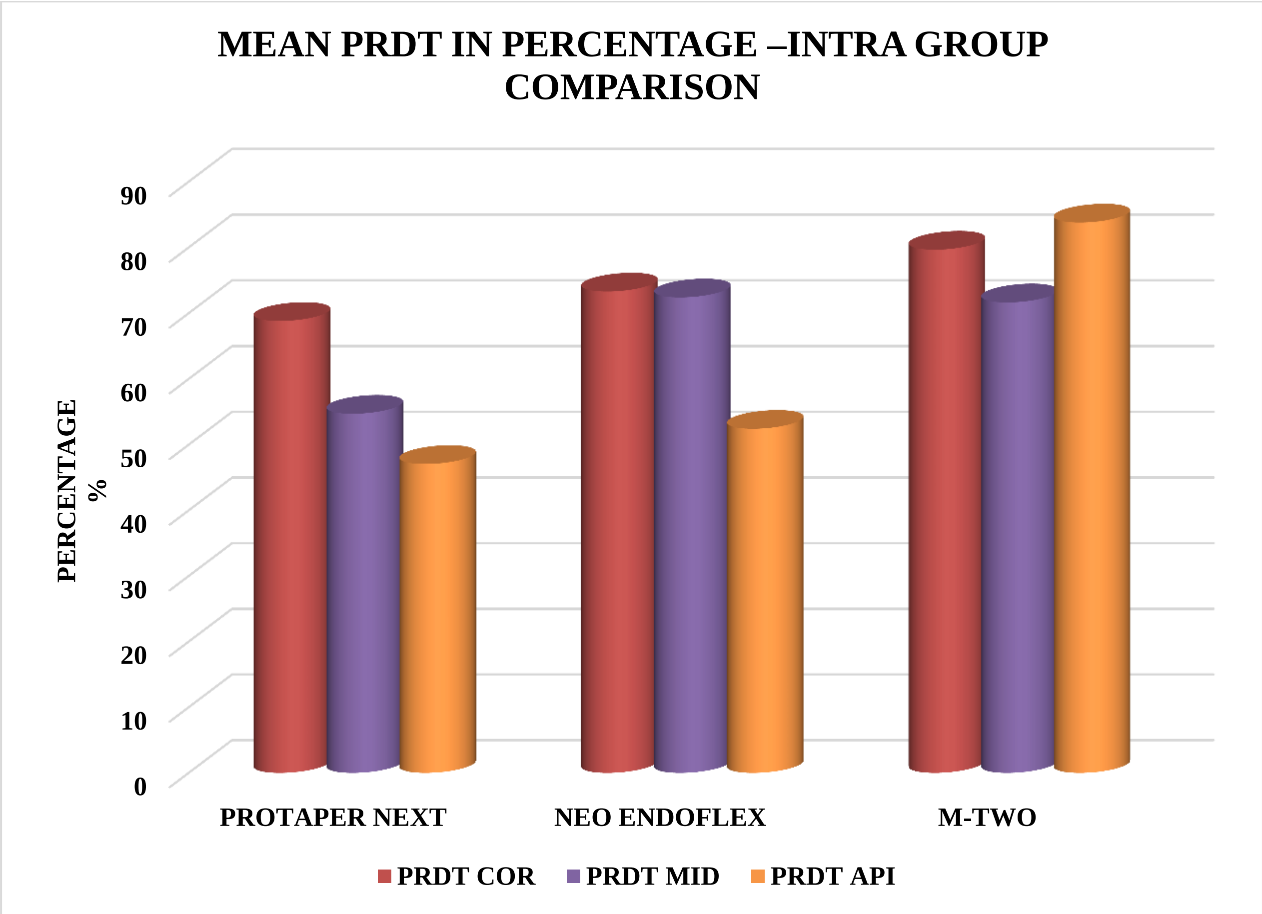
It is also clearly shown that MTwo retains dentin thickness at all levels (coronal, middle and apical thirds) almost equally ,but slightly lesser in middle third but this was not statistically significant.

Table-6a: Intra- group comparison by Tukey HSD post hoc test:

Dependent Variable	(I)PORTION OF CANAL	(J)PORTION OF CANAL	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
PRDT_PROTAPER NEXT	CORONAL	MIDDLE	14.10	7.82	.188	-5.300	33.519
		APICAL	21.74*	7.82	.026	2.332	41.152
	MIDDLE	CORONAL	-14.10	7.82	.188	-33.519	5.300
		APICAL	7.63	7.82	.599	-11.776	27.043
	APICAL	CORONAL	-21.74*	7.82	.026	-41.152	-2.332
		MIDDLE	-7.63	7.82	.599	-27.043	11.776
PRDT_NEO_ENDO FLEX	CORONAL	MIDDLE	.901	5.06	.983	-11.666	13.468
		APICAL	20.88*	5.06	.001	8.317	33.452
	MIDDLE	CORONAL	-.901	5.06	.983	-13.468	11.666
		APICAL	19.98*	5.06	.001	7.416	32.551
	APICAL	CORONAL	-20.88*	5.06	.001	-33.452	-8.317
		MIDDLE	-19.98*	5.06	.001	-32.551	-7.416
PRDT_M_TWO	CORONAL	MIDDLE	8.02	5.80	.364	-6.360	22.406
		APICAL	-4.12	5.80	.759	-18.508	10.257
	MIDDLE	CORONAL	-8.02	5.80	.364	-22.406	6.360
		APICAL	-12.14	5.80	.110	-26.531	2.234
	APICAL	CORONAL	4.12	5.80	.759	-10.257	18.508
		MIDDLE	12.14	5.80	.110	-2.234	26.531

*. The mean difference is significant at the 0.05 level.

GRAPH-2: INTRA GROUP COMPARISON OF MEAN PRDT:



CBCT IMAGES –PRE AND POST INSTRUMENTATION

GROUP-I: PROTAPER NEXT

Fig -9: PRE-INSTRUMENTATION-CORONAL-GROUP-I

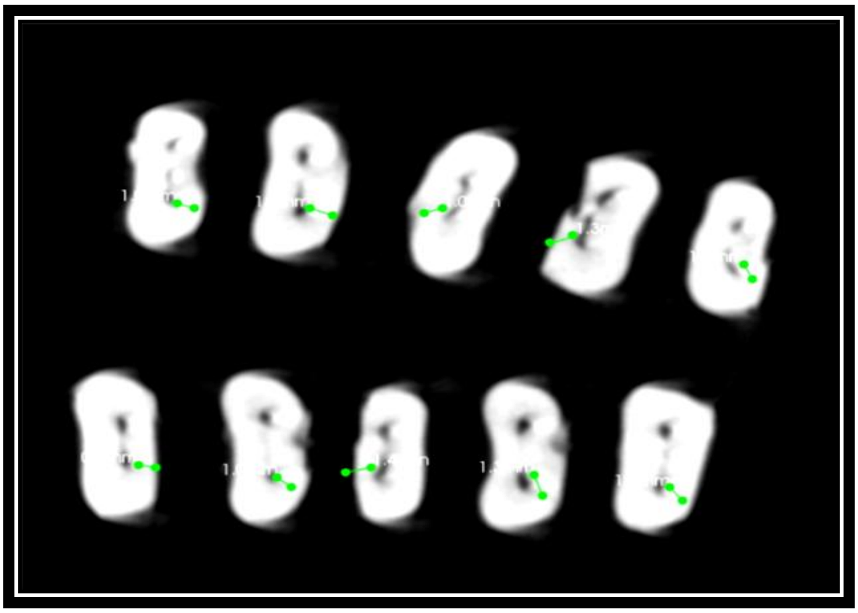
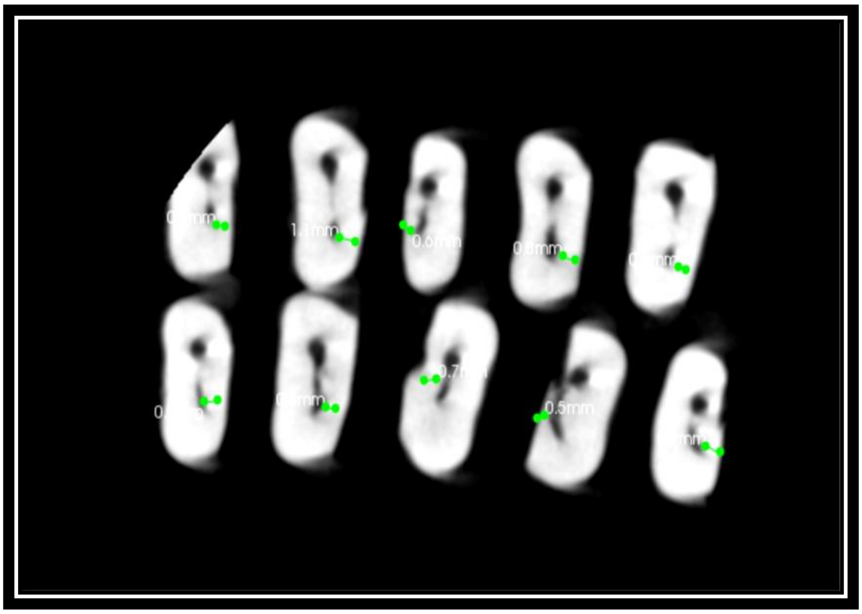
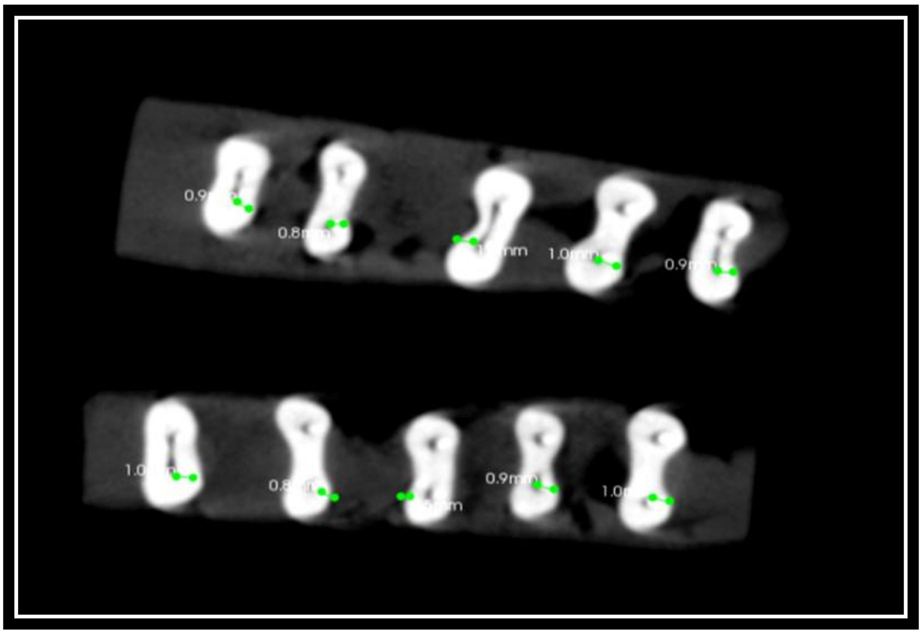


Fig -10:POST-INSTRUMENTATION-CORONAL-GROUP-I



<u>Fig -11: PRE-INSTRUMENTATION-MIDDLE-GROUP-I</u>



<u>Fig -12: POST-INSTRUMENTATION-MIDDLE-GROUP-I</u>

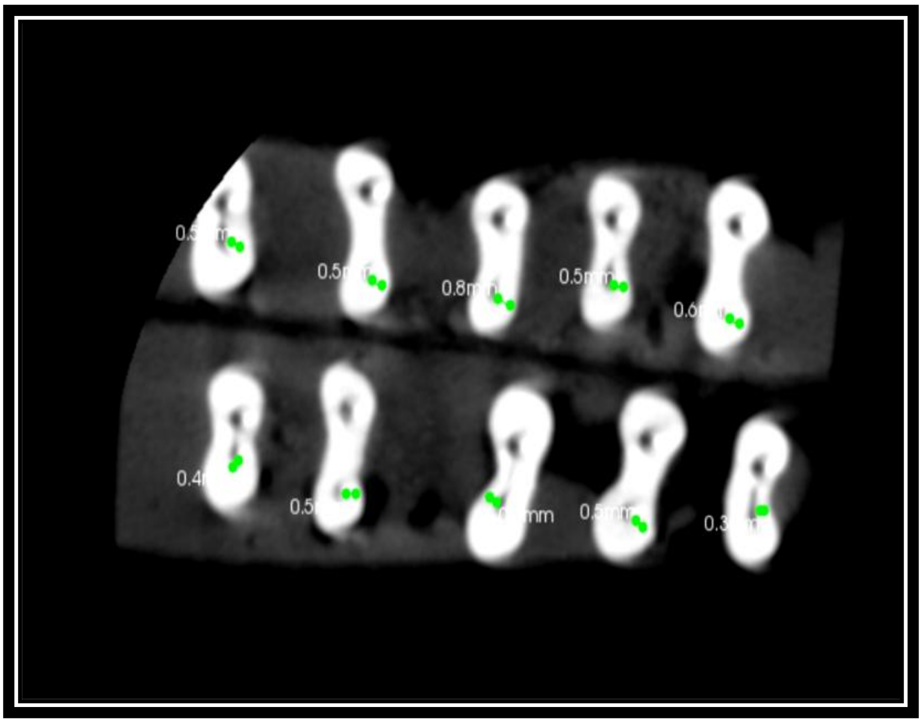


Fig -13: PRE-INSTRUMENTATION-APICAL-GROUP-I

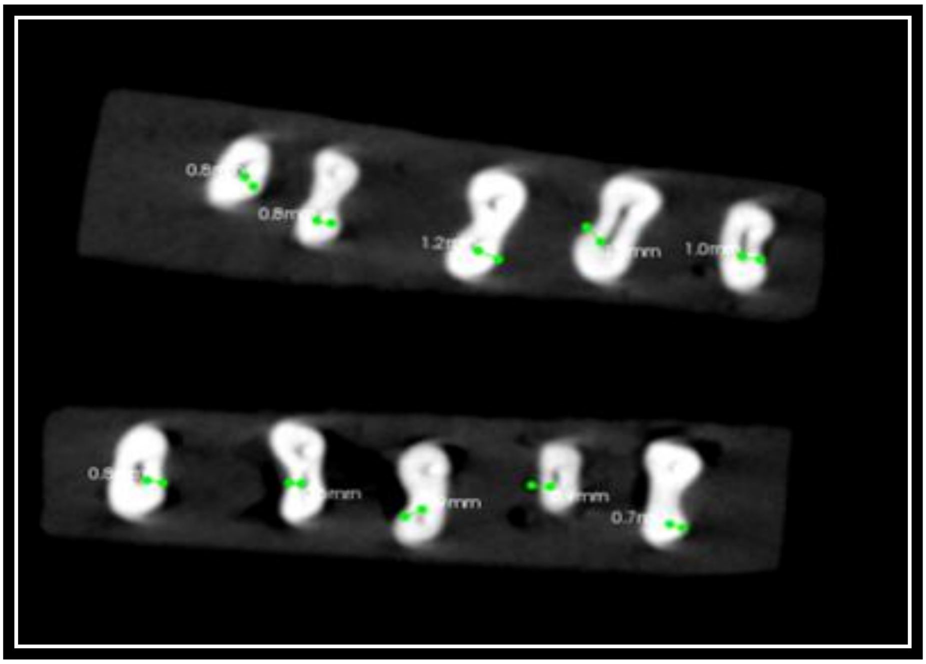
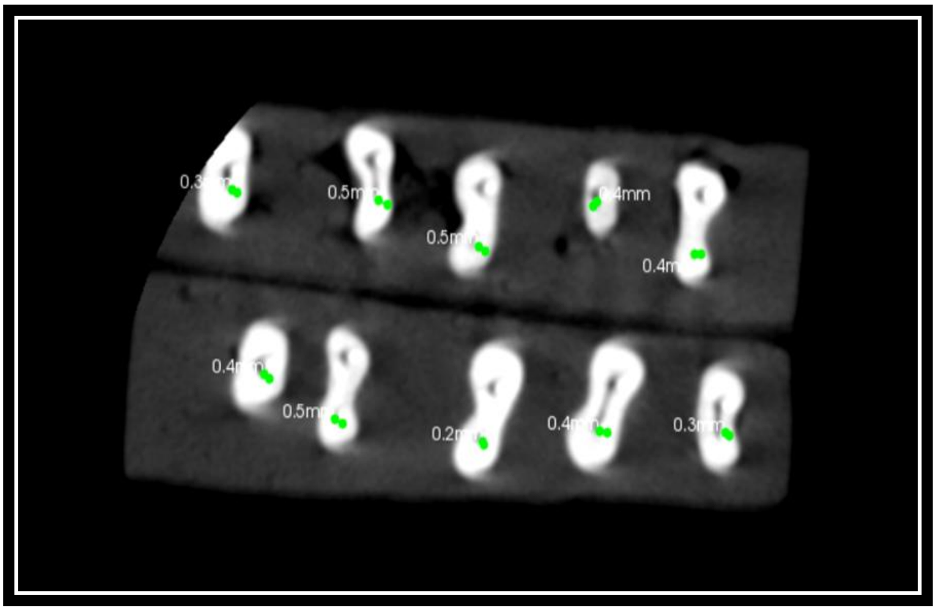


Fig -14:POST-INSTRUMENTATION-APICAL-GROUP-I



GROUP-II: NEOENDO FLEX

Fig -15: PRE-INSTRUMENTATION-CORONAL-GROUP-II

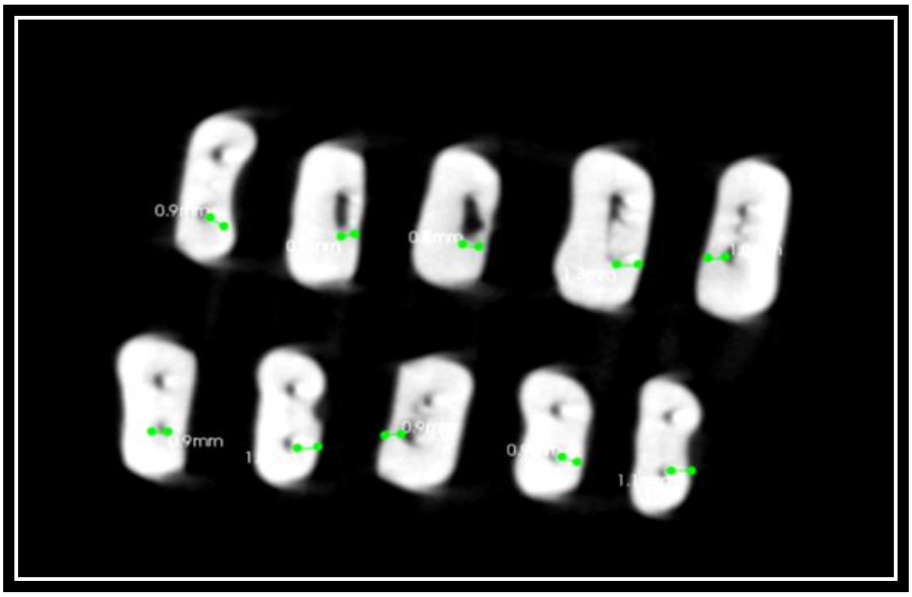


Fig -16:POST-INSTRUMENTATION-CORONAL-GROUP-II

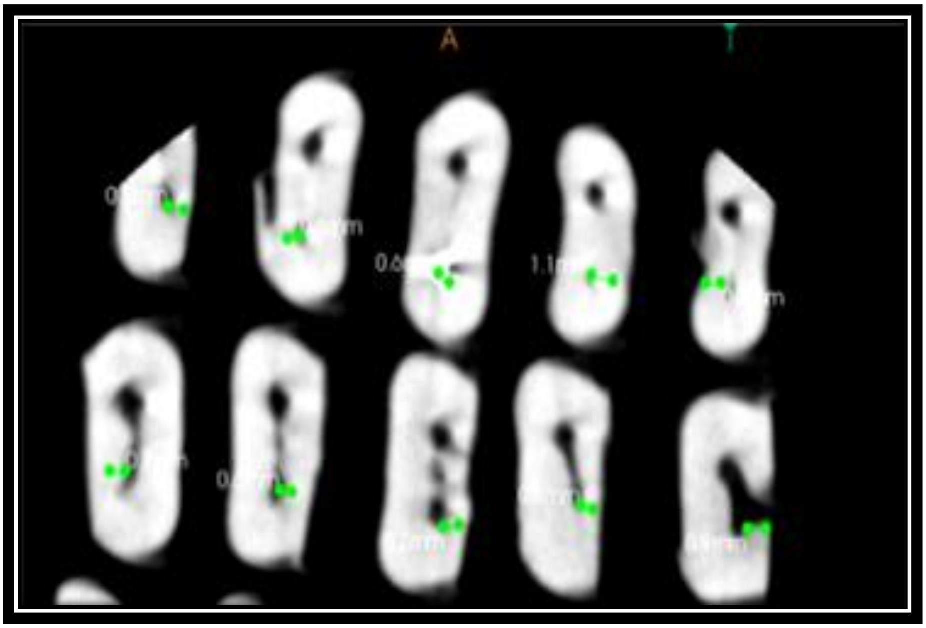


Fig -17 :PRE-INSTRUMENTATION-MIDDLE-GROUP-II

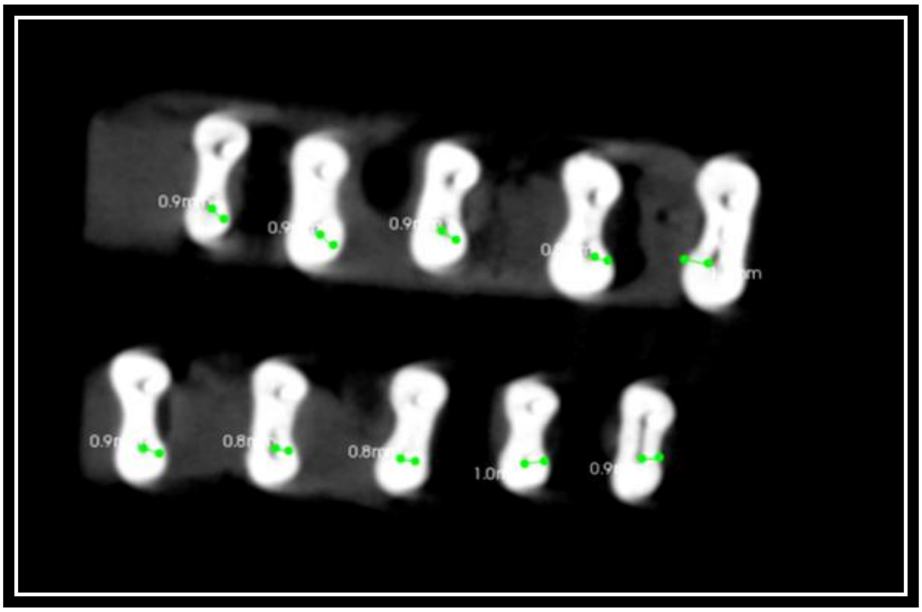


Fig -18: POST-INSTRUMENTATION-MIDDLE-GROUP-II

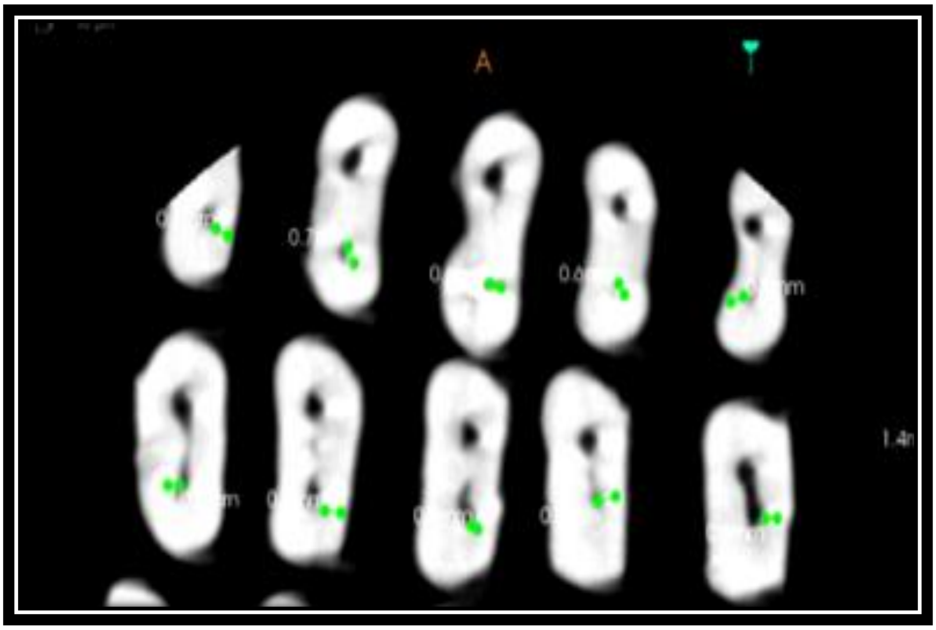


Fig -19: PRE-INSTRUMENTATION-APICAL-GROUP-II

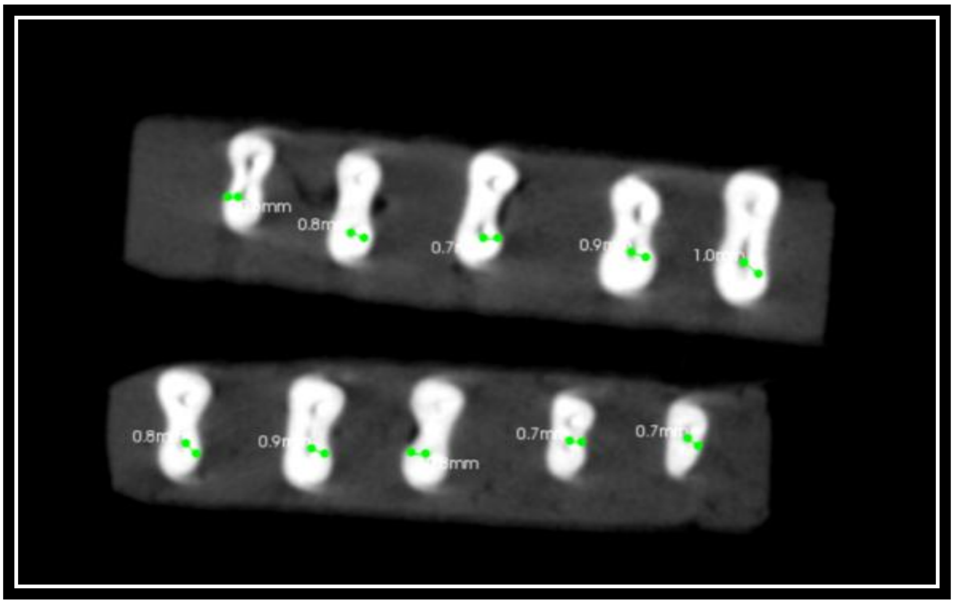
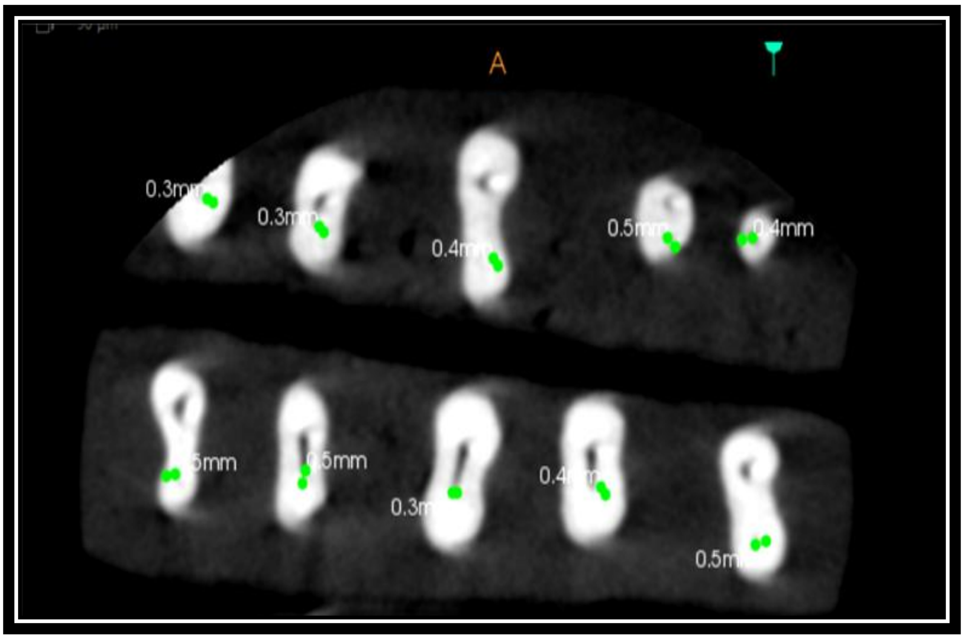


Fig -20: POST-INSTRUMENTATION-APICAL-GROUP-II



GROUP-III: MTWO

Fig -21: PRE-INSTRUMENTATION-CORONAL-GROUP-III

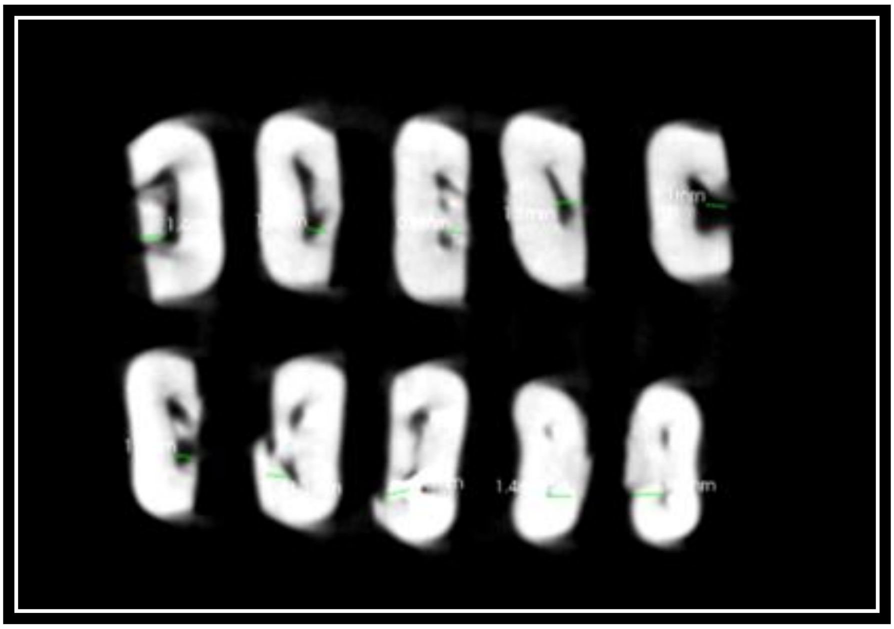


Fig -22: POST-INSTRUMENTATION-CORONAL-GROUP-III

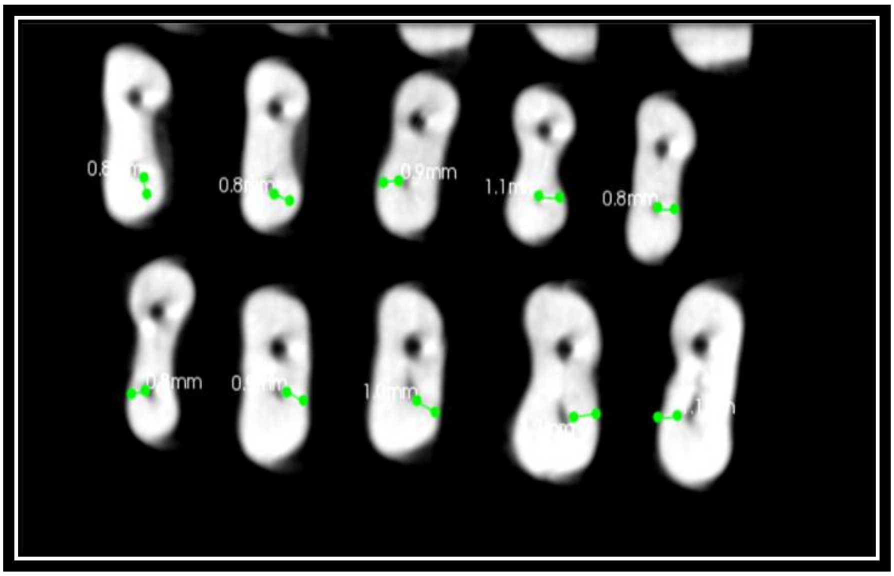


Fig -23: PRE-INSTRUMENTATION-MIDDLE-GROUP-III

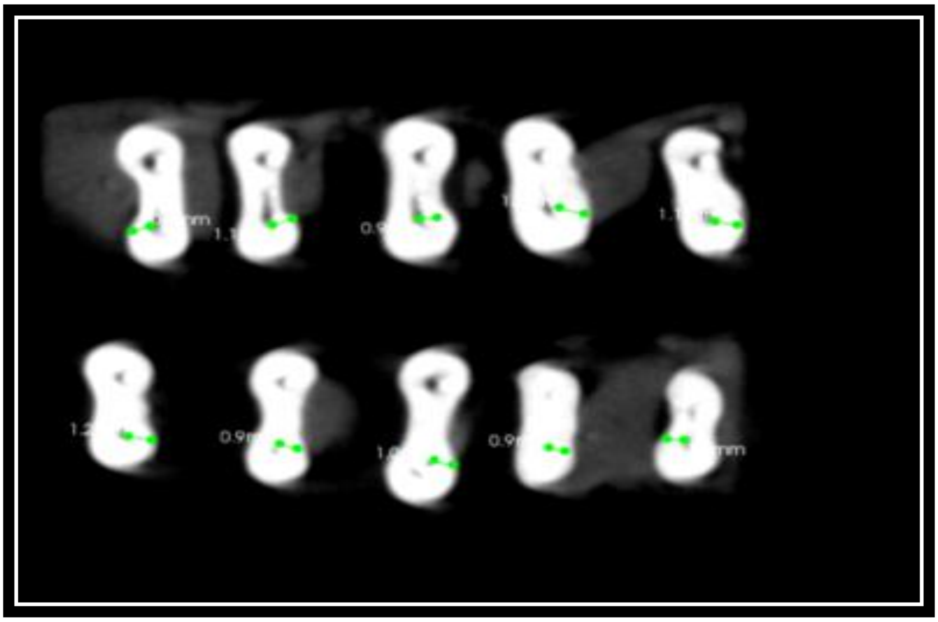


Fig -24: POST-INSTRUMENTATION-MIDDLE-GROUP-III

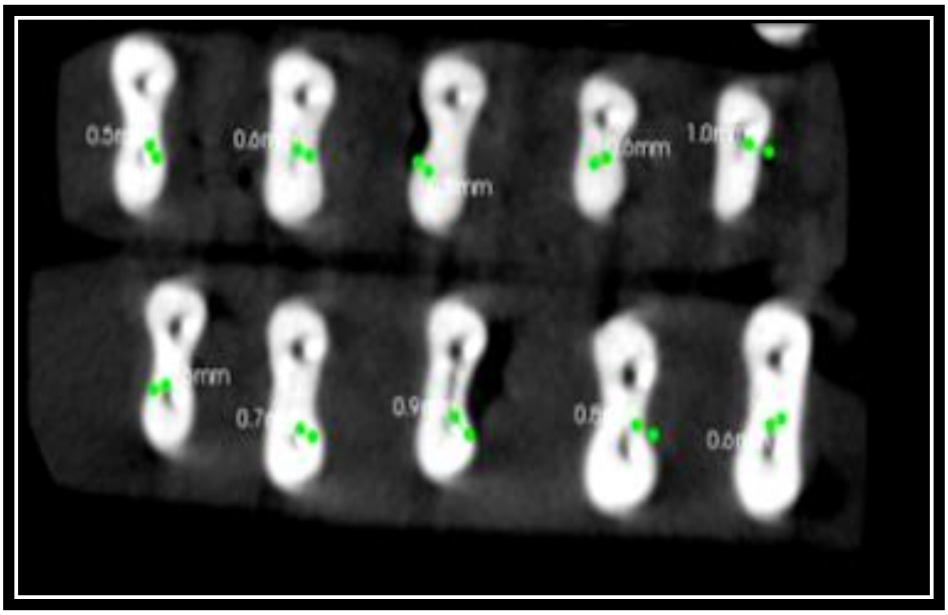


Fig -25: PRE-INSTRUMENTATION-APICAL-GROUP-III

Fig -26: POST-INSTRUMENTATION-APICAL-GROUP-III

Discussion

Cleaning and shaping of the root canal is one of the most important procedures in endodontic therapy that removes debris and root canal dentin from the inner wall regardless of the instrumentation technique. Also the main aim of all endodontic treatment is to prevent the iatrogenic damage to the tooth structure as far as possible while treating the diseased tooth.

Several characteristics of newly introduced root canal instrument with unique instrument design need to be investigated and tested in order to allow an efficient and safe clinical usage.[58] Non-surgical root canal therapy involves instrumentation that results in removal of unhealthy dentin and necrotic debris. After root canal therapy the remaining dentin thickness is most important because excess dentin removal leads to fracture of the roots [20, 57]

A direct relationship exists between the residual dentin thicknesses to the fracture resistance of the root. Preservation of sound dentin is of utmost importance. At least 1 mm of root dentin should remain in all root aspects along its entire length after all intra-radicular procedures are completed. Knowledge of the root canal anatomy is essential for successful endodontic therapy. Any false assumption regarding the thickness of root canal walls may lead to problems such as strip perforation. Strip perforations and vertical root fractures are possible outcomes of excessive removal of radicular dentin especially in zones that have been termed danger zones[72].

In this study we have selected the mandibular first molar teeth to study the remaining dentin thickness after instrumentation. Since the thickness of the distal surface of the mesial root and mesial surface of the distal root is thinner. Various studies have shown that in the first mandibular molar the thickness of the dentin is 1.2 to 1.3 mm.

A Study done by Iqbal MK, et al.[38] reported that the middle third of the mesial root of the mandibular first molar has a distal surface concavity with a root thickness of 0.7 ± 0.19 mm. Thus, the mandibular molars are easily vulnerable to perforations.

In addition to perforations, instrumentation with higher grades of instruments in the apical third of mandibular teeth could lead to reduction of the remaining dentin thickness, therefore weakens the tooth structure.

Here we have excluded the root canals with double or more curvatures and curvature more than 20 degree, according to Schneider's classification of root curvature. Incidence of ledge formation is more in case of severely curved canal. NiTi rotary files are flexible and very promising; however, multiple curves in the canals may cause strain in these instruments leading to instrument separation or ledge formation (Balani P et al)[11].

Shantiaee Y et al[69] measured the dentin thickness at 2 and 4 mm below the highest point of the furcation before and after canal preparations since the distal wall of mandibular mesial canals (DZ) has the least thickness of dentin. Similar study conducted by Rao MS et al[61] measured dentin thickness in mesio buccal root of mandibular molar at two different locations i.e., 3 and 7 mm from the apex using Clemax measuring tool.

There are many methods available to compare the effectiveness of various instruments in preparing root canals and these includes plastic blocks, [78] radiographic techniques, [77] histological sections, [49] serial sectioning, scanning electron microscope[67] and silicone impressions of instrumented canals.[14]One of the latest innovations in the industrial and medical field is the use of CBCT for study purpose, this scientific tool could develop a potential in endodontic research as well.

In this study we have used CBCT to measure the remaining dentine thickness which provides a practical and non-destructive technique for assessment of remaining root dentin thickness before and after shaping.[30] CBCT offers the cross sectional as well as three dimensional (3D images) images which are highly quantifiable and are accurate.

CBCT is also advocated for the evaluation of root canal system before and after instrumentation. It gives enough data in comparing dentin thickness before and after instrumentation. Several other studies were also utilised the advantages of CBCT for measuring dentin thickness. [7, 28, 60]

In this study, Preoperatively all the teeth were scanned using Cone Beam Computed Tomography. To assess the influence of instrumentation along the length of the canal, we measured the residual dentin thickness at three different levels ie.,coronal, middle and apical third of the root canal in an axial slice thickness of 0.1mm. The dentin thickness was measured between the canal wall and external surface of the root, perpendicular to the long axis of the root[33]. Similarly the post operatively (after instrumentation) dentin thickness was measured.

During shaping of the canal there will be an increased risk of structural loss that could occur even for an experienced clinician. Adequate taper shape will provide enough space for irrigants and allows the placement of an effective root filling. But at the same time there may be increased risk of removing excess root dentin and this may lead to root fracture.[54]

For cleaning and shaping stainless steel file systems were utilised earlier but these file system has the disadvantage of removing excess of dentin particularly in apical dentin.[26] The advent of predefined tapered shapes to root canals was given great impetus with the introduction of NiTi instruments and these NiTi instruments has good shape memory, highly flexible alloy and thus has allowed innovations in taper and flute design. This could not be achieved with stainless steel instruments.

In addition, increased taper combined with NiTi alloy allowed more predictable use of rotary methods to provide consistent canal shape.[70] Nickel-Titanium (Ni-Ti) files overcome this disadvantage by leaving thick dentin than stainless steel files.[18] The Ni-Ti files led to lower instrument failure, thus offers a safe alternative for the treatment of canals with an accentuated curvature. These instruments have many advantages like they are more flexible and have increased cutting efficiency[79]. In this study we have assessed the RDT before and after canal instrumentation using three different file systems (PTN, Neoendo Flex, MTwo) in order to evaluate the ability of the instruments in the preservation of the dentin.

ProTaper NEXT instruments (Dentsply Maillefer), recently introduced are made from M-wire. ProTaper NEXT having uniform taper system, which is rectangular in cross section of which only two sides touches the root canal. It is characterized by an innovative off-centred rectangular cross section that is claimed to give the files a snake-like swaggering movement as it advances into the root canal. The pitch length increases from the tip to the shaft. This design feature may have an impact on the screwing effect, intra-operative torque values and the cleaning ability of the instruments[15].

The MTwo system (VDW, Munich, Germany) is specially designed for apical preparation. The cross-section of MTwo is an 'italic *S*' with two cutting blades. It has a positive rake angle with uniform taper design. The Helical angle of MTwo instruments is variable and specific for the different files.

Neoendo Flex files are one of the latest rotary endodontic files used in root canal treatment. These new endodontic rotary files were manufactured keeping in mind the limitations of conventional shape memory rotary files in endodontics. Neoendo Flex Files undergo a specialized heat treatment process to give them unique flexibility characteristics.

Neoendo Flex Files have excellent cyclic fatigue resistance. The triangular cross section with sharp cutting edges increases cutting efficiency. Avoiding accidental apical transportation becomes easier with the safety tip (non-cutting). The extreme flexibility of this canal favours negotiation of any canal.[35]

In this present study we have compared the ProTaper NEXT (group-1), Neoendo Flex (group-II) and MTwo (group-III) file system in retaining dentine thickness. There were many studies available to compare the efficiency of various file system in retaining dentine thickness except Neoendo Flex file system which was recently introduced in the field of endodontics and were evaluated with various imaging techniques.

The present study results of inter group comparison of three file system used in this study showed that ProTaper NEXT (Goup-I) and Neoendo Flex (Group-II) file systems were effective in retaining dentin thickness at the middle third of the teeth when compared to MTwo (Group-III) file system which was effective in retaining dentin thickness at apical third and was found to be statistically significant with $p<0.05$.

MTwo file system used in this study showed promising response of retaining more dentin thickness in all levels but significantly more at apical third than other two system. Neoendo Flex comes next in retaining dentin thickness than ProTaper NEXT file system.

Rao et al[61] did an In-Vitro study, in which MTwo file system showed better results in retaining dentin thickness when compared to ProTaper,K3, light speed LSX,K file systems and the findings of our study also produced similar results i.e.,MTwo retained more dentin than Neoendo Flex and ProTaper NEXT files.

In this study intra group comparison was made to identify effectiveness of these instruments in retaining dentin at three different locations and the results showed that MTwo group was equally effective in retaining dentine thickness in all three locations ($p>0.05$) but Neoendo Flex group has significantly higher effectiveness in retaining dentin thickness at middle and coronal third when compared to apical third ($p=0.001$). In our study ProTaper NEXT retained more dentine at coronal third when compared to middle and apical third which is in contrast to other study[60] , in which ProTaper NEXT removed more dentin at the coronal part than the middle and apical third. This is because PTN X1, X2, files present a progressive taper in the apical part and a decreasing taper in the apical part.

In another in vitro study by Ramanathan S et al [60] evaluated the remaining dentin thickness of teeth using three rotary instrumentation i.e., ProTaper, ProTaper NEXT and MTwo. They concluded that ProTaper Universal and ProTaper NEXT should be used judiciously, as it causes higher thinning of root dentin of the root when compared with MTwo. These findings were similar to the current study.

They also claimed that progressive taper along the cutting surface in combination with the sharp cutting edges was the major reason of removal of more dentin by ProTaper and ProTaper NEXT file systems and this was supported by Ruddle et al.[62]

From our study we also noted that all three instruments almost equally remove the dentin in coronal third of teeth but MTwo showed superior results.

In accordance with the study conducted by Ramanathan S (2015)[60] , MTwo files retain more dentin , since it has a positive rake angle, uniform taper design; S shaped cross section, removes less dentin and maintain the canal anatomy. Due to this feature MTwo achieves equal as well as minimal reduction in dentin thickness on all the locations.

Generally the heat treatment of an alloy may predispose the instruments to plastic deformation and disruption of cutting edges during its use and reducing its cutting ability. Proprietary heat treatment impacts a reduced restoring forces and as a result these instruments remain more centered in the canal. This might be the reason for the less removal of dentin in the Neoendo group at coronal and middle thirds of root canal.

One of the main advantages of the CBCT is cost effectiveness. Although CBCT had been used in our study to determine the RDT, the resolution is lower than the Micro CT. The Voxel size of CBCT used in this study was 90 micro meter, but Micro CT provides 10 micrometer voxel size. With this Voxel size the RDT can be better evaluated.

Instrument selection plays an important role to minimize unnecessary weakening of tooth structure and to retain the original shape of the canal, to maximize the cleaning effectiveness and to achieve the optimal results. After the biomechanical preparation RDT is an important factor to be considered, because any iatrogenic cause may result in root fracture

Summary

The major objectives of root canal instrumentations are elimination of residual pulp tissue, removal of debris and maintaining original root curvature during enlargement. The remaining dentin thickness is one of the most important factors which offer fracture resistance of the root during intraradicular procedures. Excessive flaring of coronal third considerably reduces the residual dentin thickness which may increases the susceptibility of vertical root fracture. Moreover, preparation of the apical third can also reduce residual dentin resulting in weakened apical root structure.

The aim of this study was to evaluate the dentin thickness before and after instrumentation with three different rotary instruments namely ProTaper NEXT (Group-I), Neoendo Flex (Group-II) and MTwo (Group -III) file system. Freshly extracted human Mandibular molar teeth (30) with curvature of less than 20 degree were selected for this study. The thirty specimens were randomly divided into three experimental groups containing 10 teeth each namely, GROUP 1: ProTaper NEXT (n=10), GROUP 2 : Neoendo Flex file (n=10), GROUP 3: MTwo file (n=10).

All the teeth were scanned using a Cone Beam Computed Tomography (84Kvp, 5.0mA, 90mmVoxel, and Exposure time-20 sec, Effective dose-598microseivert) to determine the dentinal thickness of the root canal before instrumentation. The teeth were scanned and the dentin thickness were measured at 3mm, 7mm and 12mm from the apex of the canal. PRDT calculated for all the rotary instruments at three different portions of the root were tabulated and analyzed statistically using SPSS-Version 22 (IBM Corp).

The following results were obtained

- There was statistically significant difference in mean percentage remaining dentinal thickness in Neoendo Flex group (72.41±14.22) in middle third of the teeth when compared to ProTaper NEXT (Goup-I) (54.72±14.37) which was statistically significant ($p<0.05$) but not with MTwo (Group-III) (71.65±18.63) file system($p>0.05$).
- Also, Mtwo group has the advantage of retaining dentinal thickness at apical third of teeth when compared to other two instruments and this was statistically highly significant with the p value =0.000.
- At coronal third of the root canal no statistical difference was observed in all three instrument groups in terms of retaining dentin thickness($p>0.05$).
- Neoendo Flex group has significantly higher effectiveness in retaining dentin thickness at coronal and middle third when compared to apical third ($p=0.001$).
- MTwo group has almost equally effective in retaining dentine thickness at three different locations.
- ProTaper NEXT is effective in retaining dentin thickness at coronal third when compared to apical third and this was found to be statistically significant ($p<0.05$).

Conclusion

- From this study we concluded that MTwo has the advantage of retaining dentin thickness at all locations but more significantly in apical part when compared to ProTaper NEXT and Neoendo Flex file systems.
- Neoendo Flex file system also showed promising results in retaining dentin thickness which was comparable to MTwo file system but better than ProTaper NEXT.
- Though Neoendo Flex file system was recently introduced in the field of endodontics, its effectiveness should be evaluated further in terms of retaining dentin thickness.
- ProTaper NEXT file system should be used cautiously as these file system removed more dentin than other two file systems.

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